MANITOBA ENVIROTHON

WILDLIFE ECOLOGY

PROVINCIAL RESOURCES

ACKNOWLEDGEMENTS

We would like to thank:

Olwyn Friesen (PhD Ecology) for compiling, writing, and editing this document.

Subject Experts and Editors:

Barbara Fuller (*Project Editor,* Chair of Test Writing and Education Committee)

Lindsey Andronak (*Soils*, Research Technician, Agriculture and Agri-Food Canada)

Jennifer Corvino (*Wildlife Ecology*, Senior Park Interpreter, Spruce Woods Provincial Park)

Cary Hamel (*Plant Ecology*, Director of Conservation, Nature Conservancy Canada)

Lee Hrenchuk (*Aquatic Ecology*, Biologist, IISD Experimental Lakes Area)

Justin Reid (*Integrated Watershed Management*, Manager, La Salle Redboine Conservation District)

Jacqueline Monteith (*Climate Change in the North*, Science Consultant, Frontier School Division)

SPONSORS

INTRODUCTION TO WILDLIFE

Wildlife is defined as animals that are undomesticated and most commonly free-living. They include more than just the mammals and birds living in a wilderness area. Every form of virus, soil organisms, insect, no matter where it lives, is a wild species. The basic habitat needs of food, water, cover, and space are essential to maintaining healthy populations of diverse species in their respective ecosystems. Maintaining a healthy, biodiverse environment is the key to species survival. Biodiversity means the variety of life on Earth. It is most commonly measured as the variety within a species (known as genetic diversity), the variety between species, and the variety of ecosystems. Education and good management practices are needed to ensure a future in maintaining healthy, biodiverse ecosystem.

Canada and Manitoba in particular, has a vast abundance of wildlife resources. The diversity of habitat types has paved the way for diverse ecosystems. The commercial, game, aesthetic, ethical, scientific and ecological values of wildlife have captivated everyone's interest in these organisms and their naturally associated environments.

ECOLOGY

Ecology is the study of the inter-relationships among and between organisms (including wildlife) and all the aspects (living and non-living) of the environment. Organisms compete with other individuals for food and other resources. They also prey upon others, parasitize them, provide them food, and change their physical and chemical environment. Interactions between species can take various forms. Neutral interactions will have no effect on individuals or populations. Positive interactions will benefit either individuals or populations. These interactions are known as mutualism (+/+). In some situations the relationships are one sided where one group or species or individual is benefited while the other is neither benefited nor harmed. This is known as commensalism (+/0). An example of a commensalism is between trees and epiphytes, small plants that grow on the branches of trees. Amensalism (-/0) refers to a relationship where one population or individual is negatively affected while the other remains unaffected. Predation and parasitism (+/-) are two other relationships in which one group is positively affected while the other is negatively affected. Predation involves the killing and consumption of the prey whereas parasitism is an interaction where on (usually small) organism lives on or in another (the host) from which it obtains nutrients. Relationships between populations or species can

also have a negative effect on both parties. **Inter**specific competition represents a negative interaction between two **different** species. **Intra**specific competition represents a negative interaction between two individuals of the **same** species.

Ecosystem – a community of living things interacting with each other and the physical environment. An ecosystem can be a planet, the boreal forest, a stand of trees, a lake, or a fallen log.

Organism – any living individual system (e.g. animal, fungus, microorganism, plant, etc.)

Population – a group of organisms, all of the same species, that live in a particular area

Community – any group of populations of different organisms that are found living together in a particular environment. The organisms interact and give the community a structure.

Habitat

All living things have basic habitat needs, four of which are: food, water, cover, and space. When these needs or habitat factors are in good supply, they contribute to the well-being of wildlife. A short supply of any factor will limit the number and distribution of wildlife and is called a limiting factor. An animal's habitat must provide these basic needs in the proper 'arrangement', which is known as the fifth basic habitat need. Each species of animal has its own habitat requirements.

Food – all animals need food to meet their energy needs: to grow, reproduce, escape predators, and survive chilling winters or long migrations. Each species selects particular foods from the foods that are present in its environment. Some species are more specific about their food selection than others (e.g. specialist versus generalist).

Cover – many animals need shelter or cover to hide in, to raise young, and to protect them from harsh conditions. Dense vegetation is the most common kind of cover, but cover may also include rock piles, burrows in the ground, holes in logs, or bodies of water. Some small animals such as beaver and muskrats, build their own cover in the form of houses.

Water – all animals need water. Many wildlife species get enough water from the food they eat, such as succulent plants, but some also need to drink water.

Space – animals need space to survive. Overcrowding leads to severe competition for food and breeding sites, and eventually to malnutrition and rapid spread of parasites. Most animals are territorial to some extent; that is, they will occupy specific sites sometimes known as their home range. Their territoriality tends to ensure spacing and prevent over-

crowding. Because of the need for space, a given area will only support so many animals. Many species have very particular needs for breeding sites. Dense forest cover is needed by moose to conceal newborn calves and by tree-nesting birds to hide their nests. Bald eagles need large old trees to support their bulky nests and these trees must be near the shorelines where they feed. Hole-nesting birds need snags and old trees in which to excavate nests, falcons need cliff ledges, and seabirds that nest in colonies need secluded islands. Some mammals, like foxes, wolves and bears, need particular soil conditions for digging their maternity dens.

Arrangement – the arrangement of food, cover, water and space is important in determining the numbers and distribution of wildlife. For many species of wildlife, the best arrangement is in small blocks that produce edges. For other species, they need large tracks of land that are undistributed by any development for survival.

Carrying capacity

Every region has a limited amount of resources. Due to its limit in resources, it can only support so many animals. The number of animals that an area can support without damage to the habitat or animals is called the carrying capacity. The uppermost limit on the size of a population is often determined by the availability of food. For example, the growth of plants depends on the supply of nutrients and solar energy. The quantity of plant material produced determines, in turn, the maximum possible population of herbivores. The number of these animals will then set a limit to the number of carnivores. Food is not the only limiting factor on the growth of a population and so the maximum size of the population may never be reached. For example, there may be enough food to sustain thousands of birds in a region but not enough nesting sites.

Some animals can increase in numbers very quickly and may exceed their carrying capacity temporarily. This results in severe depletion of resources, environmental deterioration, social stress, increased competition for food and possible starvation, and greater exposure to parasites (leading to increased disease), predation, poor reproductive success, and damage to the habitat. For example, multiplying muskrats can very quickly eat all the vegetation in a marsh and then die out. The few individuals that were able to find food while it was scarce will then represent the surviving population. The vegetation will recover and the population will increase again.

Most animals are food (prey) for other animals, and when their population increases, so does the number of predators. Once the prey population has been reduced, there may be less food for some predators; their numbers will decline and a balance may again be

restored. An example of this 'cyclic population' is the relationship between the snowshoe hare and the lynx. Lynx, because of their large well-furred feet, are physically adapted to pursuing snowshoe hare and selectively feed on them. Both populations follow a ten-year cycle of boom and bust. The cycle of lynx follows that of the snowshoe hare by one or two years. For example, when snowshoe hare numbers reach their 'low', the lynx population responds with a lower survival rate of young and a lower reproductive rate in females because of the reduced food source.

Population dynamics

A population is a group of animals of the same species that occupy a particular area. Dynamics refers to motion or change from within. Population dynamics means the changes that occur in a population over time. The study of population dynamics helps explain why wildlife populations must be managed and how. Two major factors affect the population dynamics of wildlife - the birth rate and the death rate.

Birth Rate:
Generally the smaller species of wildlife have higher birth rates than the larger species. The most important factors that affect the birth rate are:

- Age at which breeding begins
- Number of births per year for each breeding female (how many times each year young are born)
- Number of young born per litter

Death Rate:
The smaller species of wildlife have higher death rates than the larger species (in general). The principal factors affecting the death rate of wildlife:

- Availability of food
- Predation and cover
- Weather
- Pathogens and disease
- Human activities

BASIC GROUPS OF WILDLIFE

Wildlife includes all non-domesticated animals within a region. Animals are multi-celullar, eukaryotic species that ingest other organisms or their products for sustenance (heterotrophs). They include species that range from small multicellular copepods to the large bison that roam the prairies. There are 35 known phyla, or groups of animals, that are currently found on earth. Below is a brief listing of some common phyla and their distinguishing characteristics.

Orange sea sponge (*Porifera*)

Porifera – have the most simple cellular organization of animals and a system of pores, with collar cells, through which water passes and they obtain nutrients from this filter feeding. e.g. sponges

Different types of coral (*Cnidaria*)

Cnidaria – have tissue level organization but no true organs and a gastrovascular cavity that serves as both the mouth and anus. They also have tentacles surrounding this opening, often containing nematocysts (for hunting and predator defence). Cnidarians have two basic body forms, the medusa, like sea jellies, and the polyp, like corals. e.g. corals, sea anemones, sea jellies, and hydra

Snail (*Mollusca*)

Mollusca – large diverse group of animals (over 50 000 species) that have soft bodies with a 'head' and 'foot' region. Often they have a hard exoskeleton made from calcium carbonate, secreted by their mantle. e.g. clams, snails, slugs, squid, and octopus

Sea flatworm (*Platyhelminthes*)

Platyhelminthes – also known as flatworms, they are unsegmented, bilaterally symmetrical worms. They have many species' in this group that are parasitic. They have no respiratory or circulatory systems as they perform these functions through their body wall. e.g. tapeworms, flukes

Nematoda – also known as round worms, nematodes are worm-like species that are surrounded by a strong, flexible layer called a cuticle. It has been suggested that there may be over 500 000 species in this phylum. e.g. hookworms, pinworms

Annelida – segmented worms, where the segments form subdivisions in the body cavity. Each segment contains parts of many body systems including circulatory, nervous, and excretory tracts. e.g. earthworms, leeches, red velvet worms

Arthropoda – This phyla has more species than all the other phyla combined, with the insects (a large group of arthropods) being suggested to have over ten million species still undescribed. Arthropods are strongly segmented affecting both the external and internal structures. They have an exoskeleton made primarily of chitin. Each body segment has a pair of jointed appendages, although these appendages may be modified or even lost. They grow by molting their exoskeletons. Further, many species of arthropods have highly developed eyesight. e.g. insects, crustaceans (lobsters and crabs), spiders, scorpions, and centipedes.

Chordata – characterized by having a structure called a notochord during some part of their development. They are bilaterally symmetrical and have a brain. Chordates also have a tail posterior to their anus at some point of development, a heart, complete digestive system, and a bony or cartilaginous endoskeleton. e.g. birds, mammals, amphibians, fish and humans.

Nematode with bean (*Nematoda*)

Earthworm (*Annelida*)

Beetle (*Arthropoda*)

Lionfish (*Chordata*)

WILDLIFE ANATOMY AND IDENTIFICATION

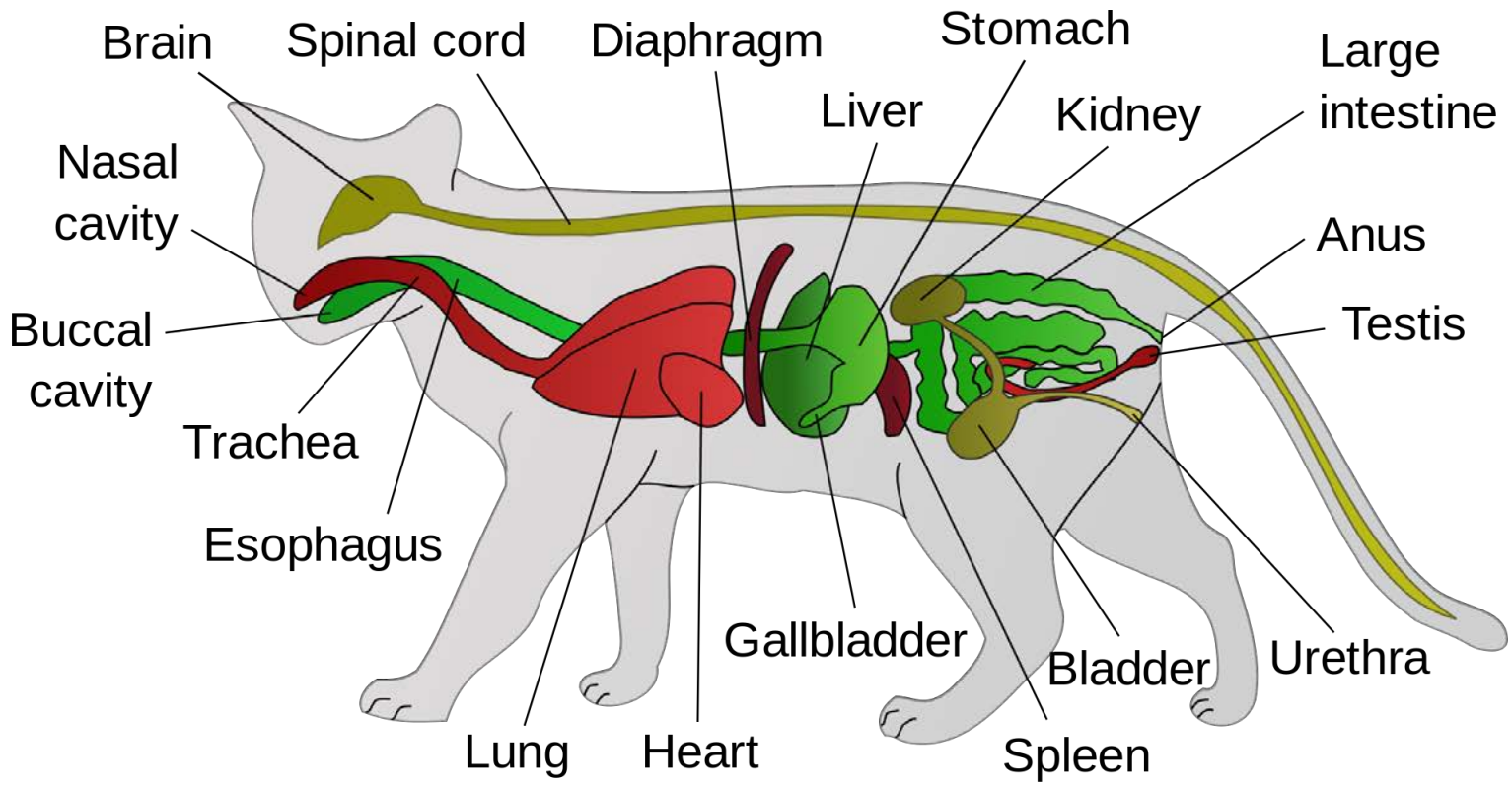
A broad understanding of basic anatomy and identification of wildlife is key when trying to understand their behaviour, abundance, diversity, as well as making management decisions within a region.

BASIC ANATOMY

Mammals are a group of vertebrate species that share a number of characteristic features. They are endothermic homeotherms, meaning they remain at a near constant temperature (most of the time, excluding during torpor or hibernation – see 'Wildlife and Winter' document) with the capacity for internal temperature control. Mammals also have hair at least at some point in their lives. This hair often aids in the control of internal temperature. Mammals also possess mammary glands that they use for nourishing their young. With a few exceptions, they give birth to live young. A few other characteristics define mammals, including a middle ear with three bones, the lower jaw is made from a single bone, and a single muscular diaphragm which splits the body cavity into two sections. The skeleton of a mammal is split into three sections, the cranium (including the skull), axial skeleton (including the vertebrae, spinal column, and rib cage), and the appendicular skeleton (including the girdles and limbs).

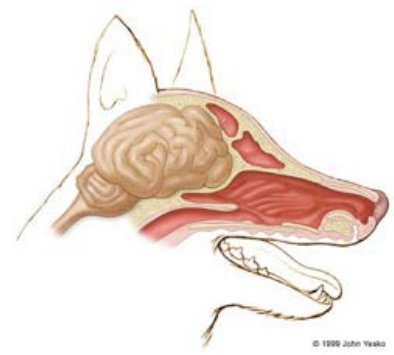
Mammals vary in their mode of locomotion. Most move quadrupedally, using all four limbs, although there are a few exceptions to this like humans who can walk upright. Mammals can be cursorial, spending much of their time running to escape predators, catch prey, or possibly migrating (e.g. pronghorns). They could also be ambulatory, spending most of their time walking (e.g. bears). How the mammal contacts the ground also varies based on the species'. Digitigrades run on one or more toes (e.g. carnivores). Unguligrades use their fingernails or hooves to contact the ground (e.g. deer and cattle). If an animal is plantigrade, the ankles to the tips of the toes are imprinted (e.g. rabbits, raccoons, and skunks). Bats are a unique as they are the only mammal to truly fly.

The mammalian body has 11 main organ systems. Each organ system uses various organs to perform its main functions. Below is a diagram and description of all major organs within a mammal and all 11 organ systems are outline below, followed by a brief description of some of their major organs.

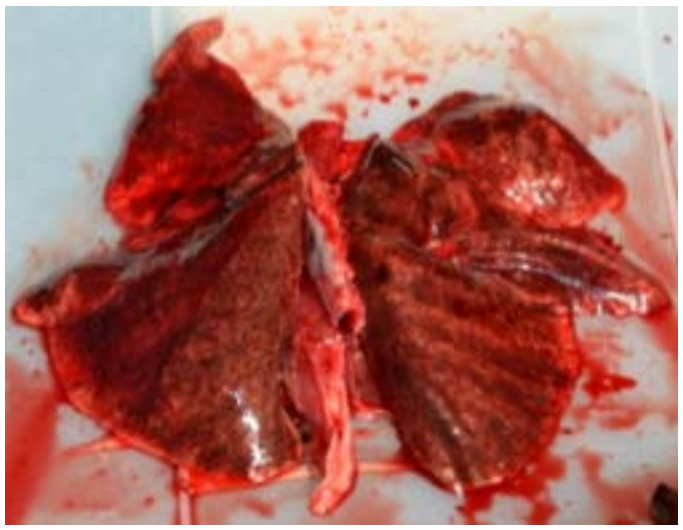


Organ system	Main components	Main functions
Digestive	Mouth, pharynx, esophagus, stomach, intestines, liver, pancreas, anus	Food processing (ingestion, digestion, absorption, elimination)
Circulatory	Heart, blood vessels, blood	Internal distribution of materials
Respiratory	Lungs, trachea, other breathing tubes	Gas exchange (uptake of oxygen, disposal of carbon dioxide)
Immune and Lymphatic	Bone marrow, lymph nodes, thymus, spleen, lymph vessels, white blood cells	Body defence (fighting infections, pathogens, disease)
Excretory	Kidneys, ureters, urinary bladder, urethra	Disposal of wastes and maintenance of osmotic balance of blood
Endocrine	Pituitary, thyroid, pancreas	Coordination of body activities
Reproductive	Ovaries, testes, and associated organs	Reproduction
Nervous	Brain, spinal cord, nerves, sensory organs	Coordination of body activities
Integumentary	Skin and its derivatives (e.g. hair, claws, skin glands)	Protection against mechanical injury, infection, drying out, thermoregulation
Skelatal	Skeleton (bones, tendons, ligaments, cartilage)	Body support, protection, movement
Muscular	Skeletal muscles	Movement, locomotion

Brain – The brain is the center of the nervous system. It is generally located in the head, close to primary sensory organs (for vision, hearing, taste, and smell). It is the most complex organ in the body and is composed of neurons that communicate with

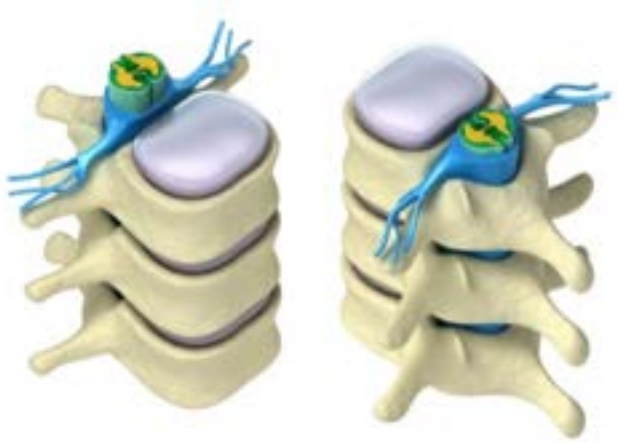


connections called synapses and glial cells, which give structural support, metabolic support, insulation, and development guidance. It is the centralized control over all the other organs of the body, allowing for rapid and coordinated responses. The image to the right is the brain and head of a canid (e.g. dog).

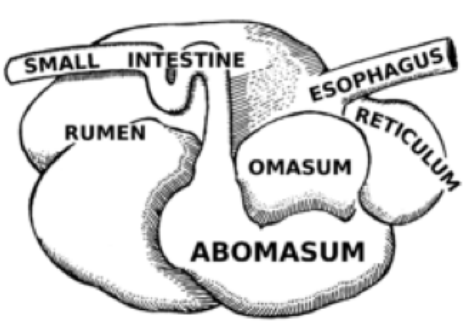


Lungs – the lungs is the mammals' essential organ for respiration. They have two lungs located near the backbone on either side of the heart. The lungs are composed of millions of specialized cells that form tiny, thin walled air sacs called alveoli. Once the air is brought through the mouth it moves through the larynx, trachea, bronchi, and bronchioles until it reaches the alveoli where the gas exchange of carbon dioxide (from the bloodstream to the air) and oxygen (from the air to the bloodstream). This breathing is driven by the muscular diaphragm which is located at the bottom of the thorax. The image to the left is a set of lungs from an arctic fox.

Spinal cord and vertebral column – The spinal cord is a long thin, tubular bundle of nervous tissues and their supporting cells that extends from the brain. With the brain, the spinal cord is part of the central nervous system. The vertebral column (also known as the backbone) is formed from the vertebrae and protects and holds the spinal cord. It is split into the cervical, thoracic, lumbar, and sacral sections.



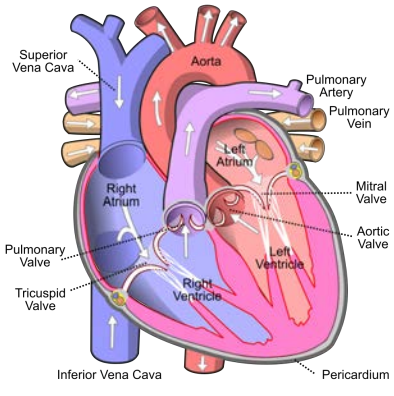
Stomach – The stomach is a muscular, hollow part of the digestion system which functions in the second phase of digestion. It is located between the oesophagus and small intestine. It secretes enzymes, such as protease, and strong acids aiding in food digestion. It also uses smooth muscular contractions (called peristalsis) to further digest the food. The food (now known as chyme) then is sent into the small intestines for further digestion. The image on the top left is a stomach from an arctic fox. The stomach of some species of mammals has evolved with their diet. For example, ruminants are a group of mammals that digest plant-based food by first softening the food in the first



compartment of the stomach through bacterial digestion and then regurgitating the semi-digested solution (known as cud) to be chewed again. The image to the bottom left roughly illustrates a ruminant digestive system. Ruminants include white-tailed deer, elk, moose, and bison.

Kidney – the kidneys (each mammal has a right and left kidney) are organs that assist in essential regulatory functions. They are essential in the urinary system and assist with homeostatic functions like the regulation of electrolytes, blood pressure regulation (through water and salt balance) as well as maintaining the pH of blood. The kidneys act as a natural filter of blood, removing wastes that are then moved into the urinary tract and excreted through the bladder. They also take up or participate in the reabsorption of sugars (glucose), water, and amino acids. Large amount of fat stores generally surround the kidneys and are one of the last places an animal will lose fat when they are starving. Wildlife biologists often use the amount of fat around the kidney as an index of the condition of the animal. The image on the right is the kidney (split down the middle) from an arctic fox.

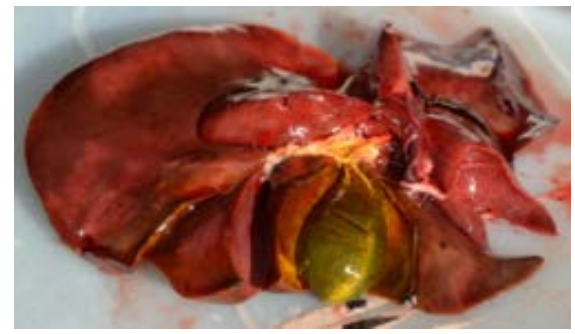
Diaphragm – this large sheet of flexible skeletal muscle that extends across the bottom of the ribs separates the thoracic cavity (heart, lungs, and ribs) from the abdominal cavity (includes the liver, stomach, intestine, kidneys, etc.). It is a key muscle in respiration. As the diaphragm contracts it increases the volume of the thoracic cavity and air is drawn into the lungs. The image on the left is a diaphragm from a red fox.



Heart – the heart is one of the key organs in the circulatory system. It is a hollow muscle which is responsible for pumping the blood throughout the blood vessels through its repeated rhythmic contractions. The heart is primarily made from cardiac muscle and connective tissue. Mammalian hearts have four chambers, two atria and two ventricles.

Liver – the liver is the largest internal organ that serves a wide variety of functions, including detoxification, glycogen storage, protein synthesis, hormone production and the biochemicals necessary for digestion. It is an essential organ for survival. It consists of four lobes of unequal size and shape. The gall bladder (seen here in green) is

closely associated with the liver. The bile is produced in the liver and collected in the bile ducts and then store in the gall bladder.

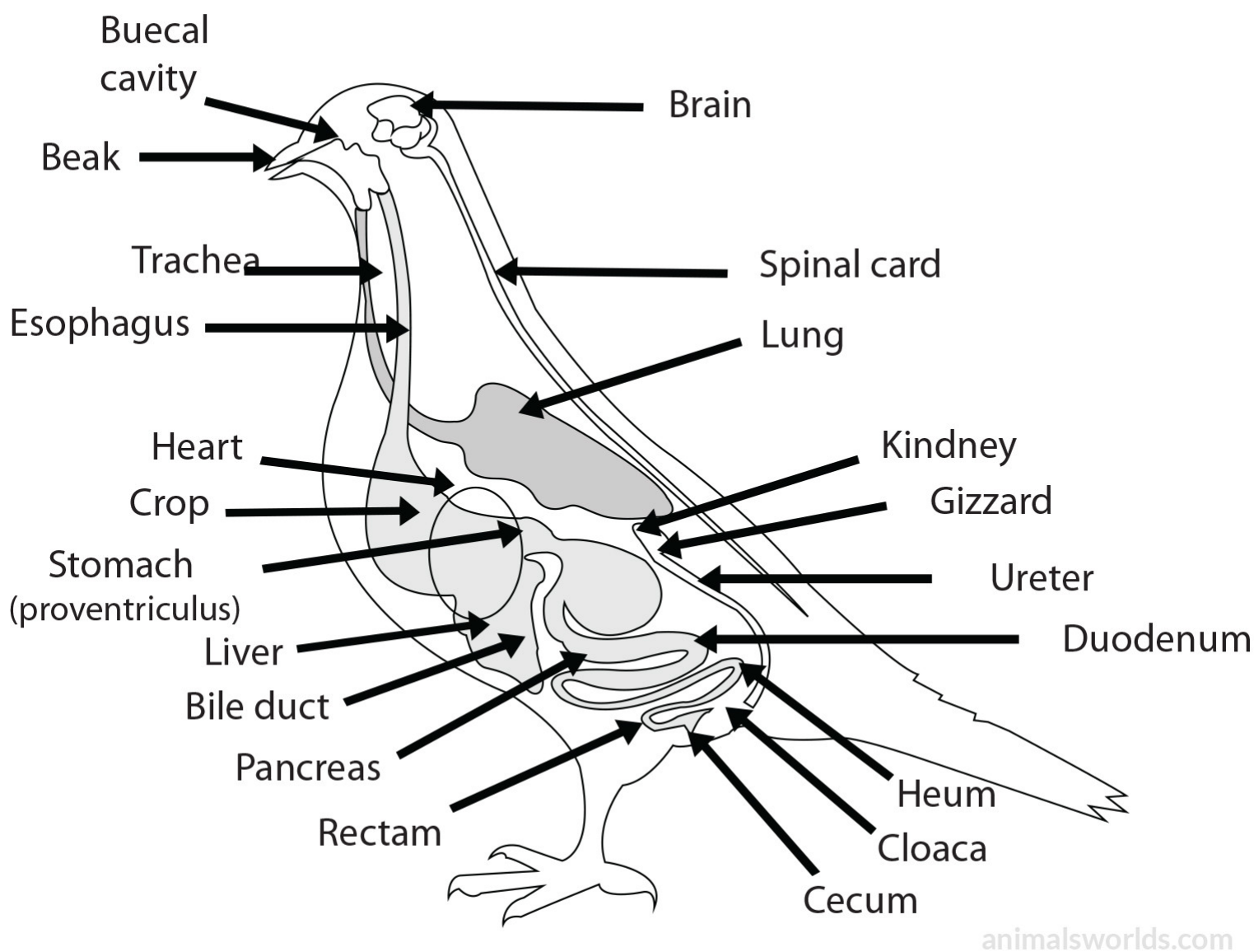


Spleen – the spleen is a small organ located in the abdominal cavity, often near the intestine. It is important for the functioning of the immune system and blood filter. It removes the old red blood cells, recycles iron, and has a reserve of blood. Since the spleen is involved in the immune system, wildlife biologists often use its mass and the proportion of white pulp mass to red pulp mass as indices of immune function. The image to the right is a spleen from an arctic fox. Note, this spleen in the image has a lesion (abnormality in tissue) on the right side.

Intestine – the intestine is a portion of the digestive system, extending from the stomach to the intestine, commonly considered to be split into two main segments, the small and large intestines. Food passes through the intestine and nutrients from this food is absorbed. The large intestine hosts many different types of bacteria that assist the mammals in breaking down molecules that they can not alone. The large intestine is also concerned with the absorption of water from the food which has been digested. The length of the intestine is often associated with the diet of the species. Herbivorous species tend to have longer, more developed intestines, whereas carnivores have shorter, small intestines. The image to the left is an intestine (with stomach attached) of a red fox.

Reproductive Organs – The reproductive system is a group of organs within an individual that work together to assist in reproduction. Sexes of mammals have different organ systems. The major organs include the external genitalia (penis in males and vulva in females), as well as internal organs including the gonads (testicles in males and ovaries in females) where gametes are found. In mammals, most males also have a baculum, or a penis bone, with humans being one exception. The uterus and vagina (found in females) are unique to mammals with nothing similar seen in any other vertebrate (e.g. birds, reptiles, amphibians, fish). The image to the right is of the ovaries, two-horned uterus, and vagina of a red fox.

Birds, also known as Aves (their class), are feathered, winged, bipedal, endothermic vertebrate animals. There around 10 000 living species of birds. They range in size from the bee hummingbird (5 cm long) to the ostrich (2.75 m long). They are characterized by their feathers, a beak that lacks teeth, laying hard-shelled eggs, high metabolic rate, and a lightweight but strong skeleton.



Many of the organs are similar between birds and mammals, including the heart, liver, brain, spinal cord, kidneys, and intestine. Birds also have crops, gizzards (both part of the digestive system) as well as a cecum.

Crop – the crop is an extension of the oesophagus that is used for food storage prior to digestion. It is particularly developed in birds that eat grains. It is not present or well developed in all birds. In some birds (e.g. pigeons and doves) the crop produces "crop milk" that is used to feed their young for the first two weeks after hatching. In many other species (e.g. ospreys) the birds will regurgitate food located in the crop and feed this to their young.

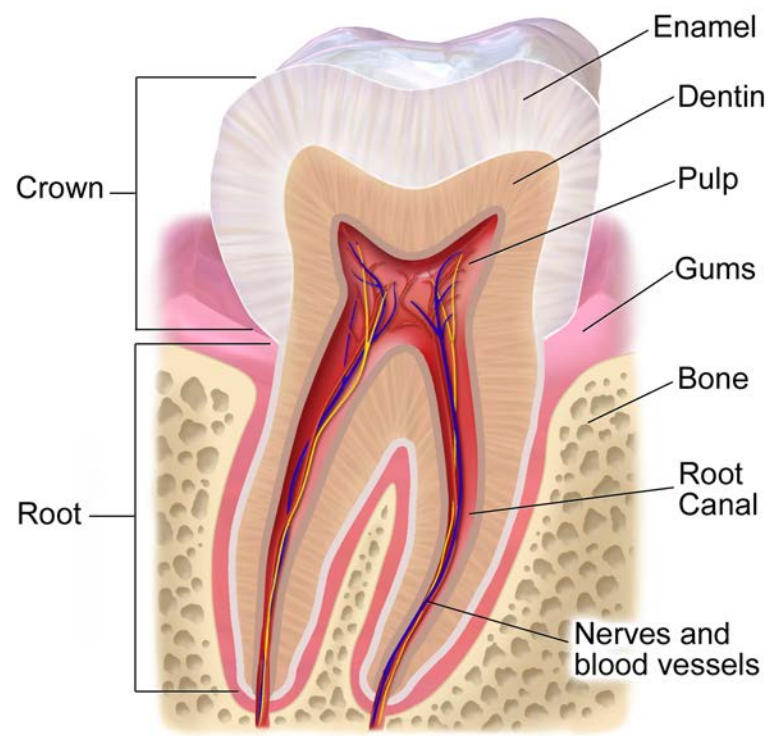
Gizzard – the gizzard is a very muscular portion of the digestive tract (part of their stomach) that can be stones or other grit that assists the bird to break down its food into small particles. It serves the same function as mammalian teeth.

Cecum – the bird cecum is a pair of small pouches that project from the large intestine where it meets the small intestine. They range in size from very long to short or entirely absent. It can serve various functions, including the digestion of small food particles, absorption of nutrients and water.

SKULLS AND TEETH

Skulls and teeth are important tools we can use not only to identify the species of specimen in the field but also can give us insights into the life of the animal, what it eats, how it forages, or even special adaptations to its environment.

Birds, reptiles, fish, and amphibians have homodont teeth (if teeth are present), meaning all the teeth are the same relative shape and morphology. Mammals are unique in the fact that they have heterodont teeth, generally including incisors, canines, premolars, and molars. They suggest that the animal has some level of hunting and or feeding specialization. Differences in the structure of mammalian teeth give some clues to the foraging activities of the species.



Tooth Anatomy

To the left is an image of the basic structure of a mammalian tooth. As the cementum layer is added annually in most species of mammals, analyzing teeth can also provide the age of the individual.

Dental formula

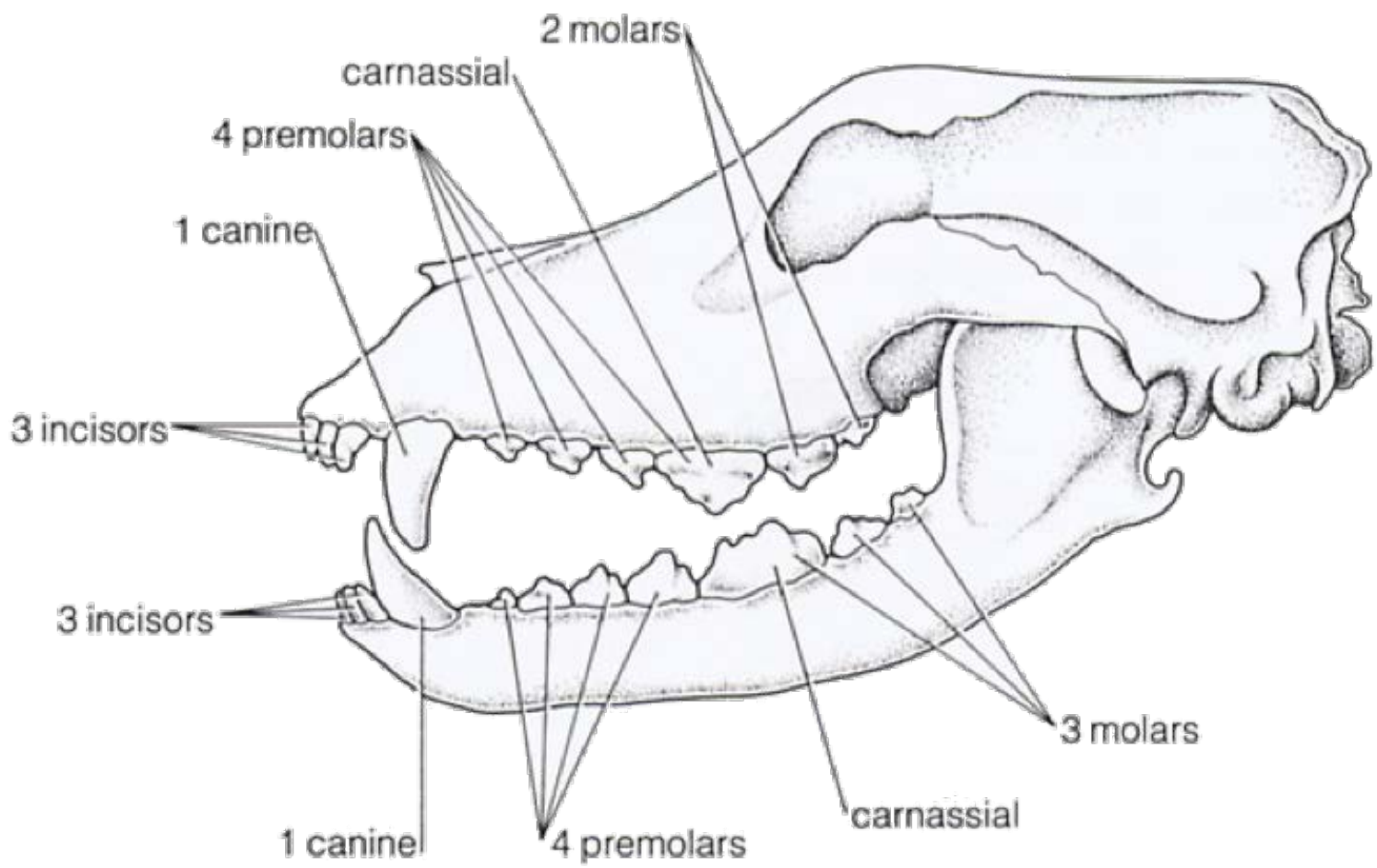
The number of different tooth types found in a skull can be expressed using the dental formula. It can then be used to identify a skull. To find the dental formula of an individual skull you must identify the number of teeth of each type (incisors, canine, premolars, and molars) on the top and bottom of one HALF of the skull (either left side or right side). Upper numbers in the fraction are for the upper teeth; lower numbers in the fraction are for

the lower teeth. The “2” in the front of the formula indicates that this arrangement of teeth is the same for both sides of the mouth.

I – Incisors, C – Canines, P – Premolars, M- Molars

$$2\left(I\frac{upper\ teeth}{lower\ teeth}\ C\frac{upper}{lower}P\frac{upper}{lower}M\frac{upper}{lower}\right)$$

For example in a dog skull,



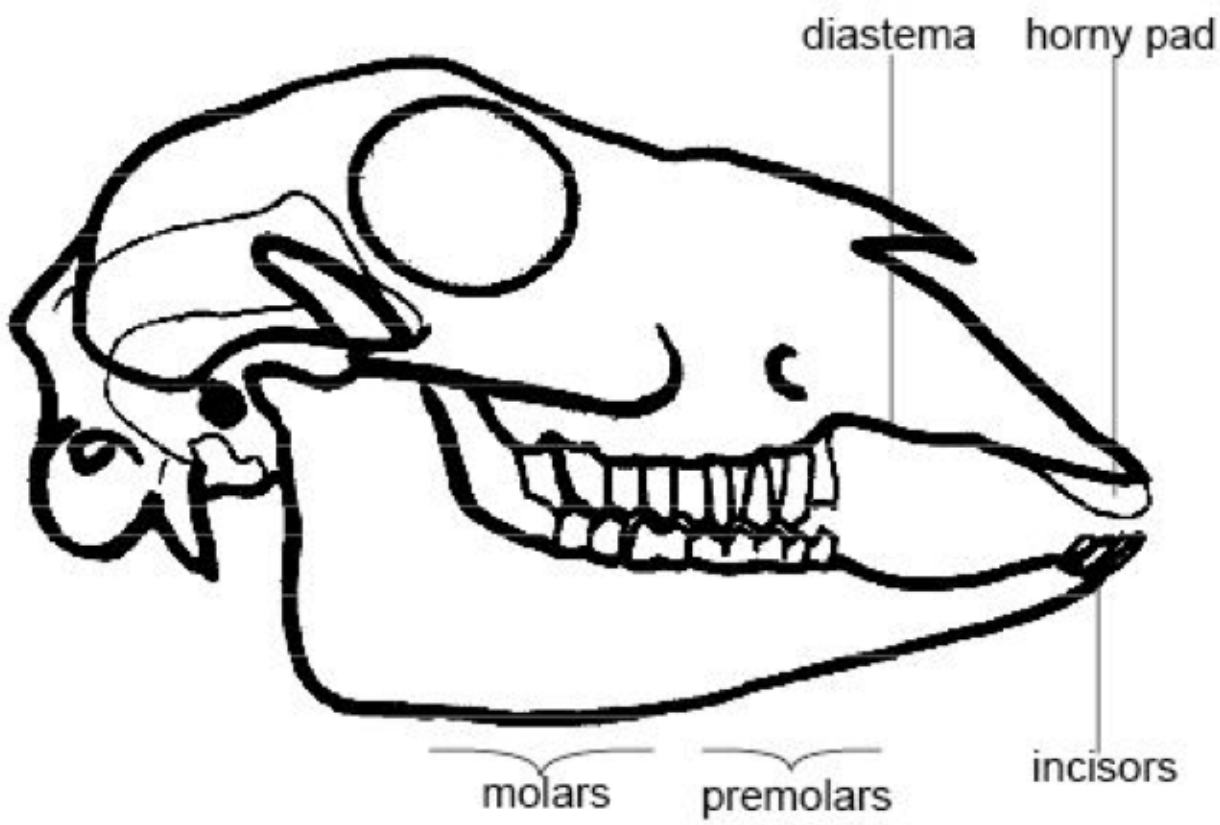
$$2\left(I\frac{3}{3}+C\frac{1}{1}+P\frac{4}{4}+M\frac{2}{3}\right)$$

$$2\left(\frac{3+1+4+2}{3+1+4+3}\right)=2\left(\frac{10}{11}\right)=2(21)=42$$

The calculation of the total dental formula involves the addition of the number of all the upper teeth plus the combination of all of the lower teeth. This is then multiplied by two (to account for the two sides of the skull) to calculate the total number of teeth in the skull. The dental formula of the individual is then reported as below:

$$(3/3,\ 1/1,\ 4/4,\ 2/3)\ =\ 42$$

A second example of a sheep's skull,

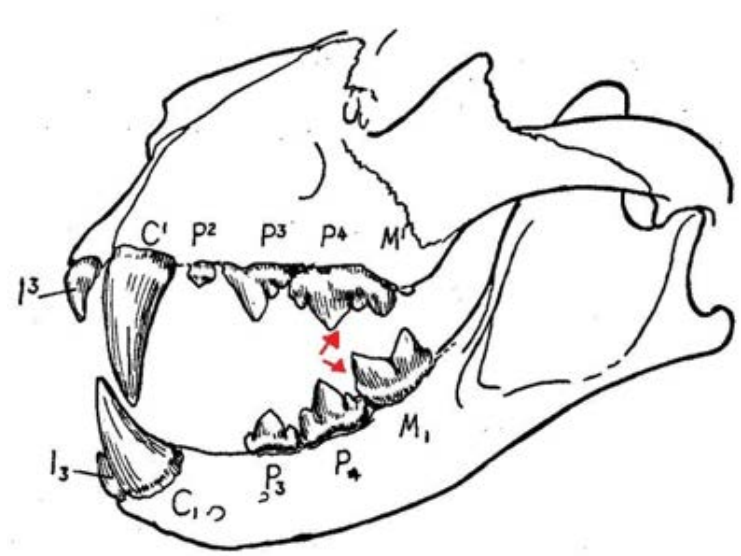


$$2\left(I\frac{0}{4}+C\frac{0}{0}+P\frac{3}{3}+M\frac{3}{3}\right)$$

So, the dental formula for a sheep would be (0/4, 0/0, 3/3, 3/3) = 32

Specialized mammalian dentition:

Carnassial Pair



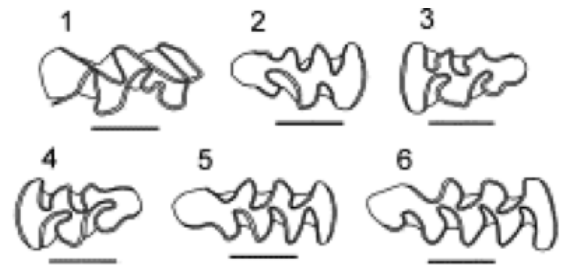
The carnassials are a pair of teeth on each side of jaw (4th upper premolar and 1st lower molar) that do most of the shearing action when a carnivore is eating meat. This tooth specialization is only found in the order Carnivora.

Cheek Teeth

These teeth (including premolars and molars) do most of the mastication of the food so they display a high amount of variation and adaptation. Examples of cheek teeth modifications include: microtine, brachyodont,

hypsodont, euthemorphic, bunodont, lophodont, and selenodont.

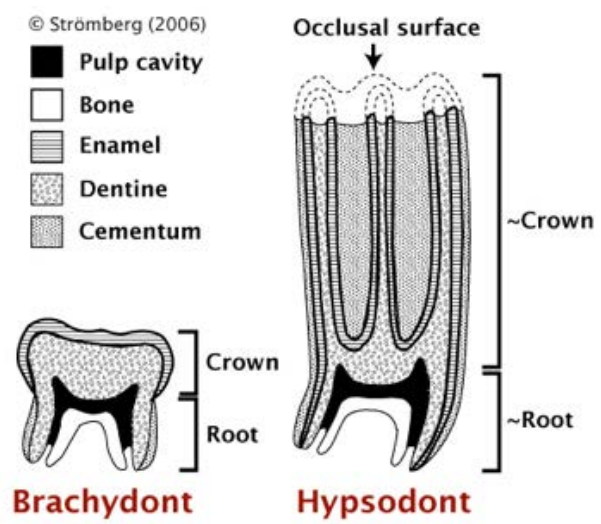
Microtine teeth are zig-zag prisms with loops. They are characteristic of many species of rodents including lemmings and voles.



Microtine teeth

Brachyodont teeth are low crowned teeth that are associated with species that are omnivorous or carnivorous, like coyotes, lynx, primates or humans.

Hypsodont teeth are high crowned check teeth that are generally seen in herbivores. In some species these teeth may be rootless and continuously grow. They are found in species such as deer, cattle, and horses.



Brachydont vs Hypsodont

Euthemorphic teeth are square shaped teeth that are found in most living mammals although their form may vary.

Bunodont teeth are euthemorphic, brachyodont teeth that are found in bears, raccoons, primates, and pigs.

Bunodont teeth

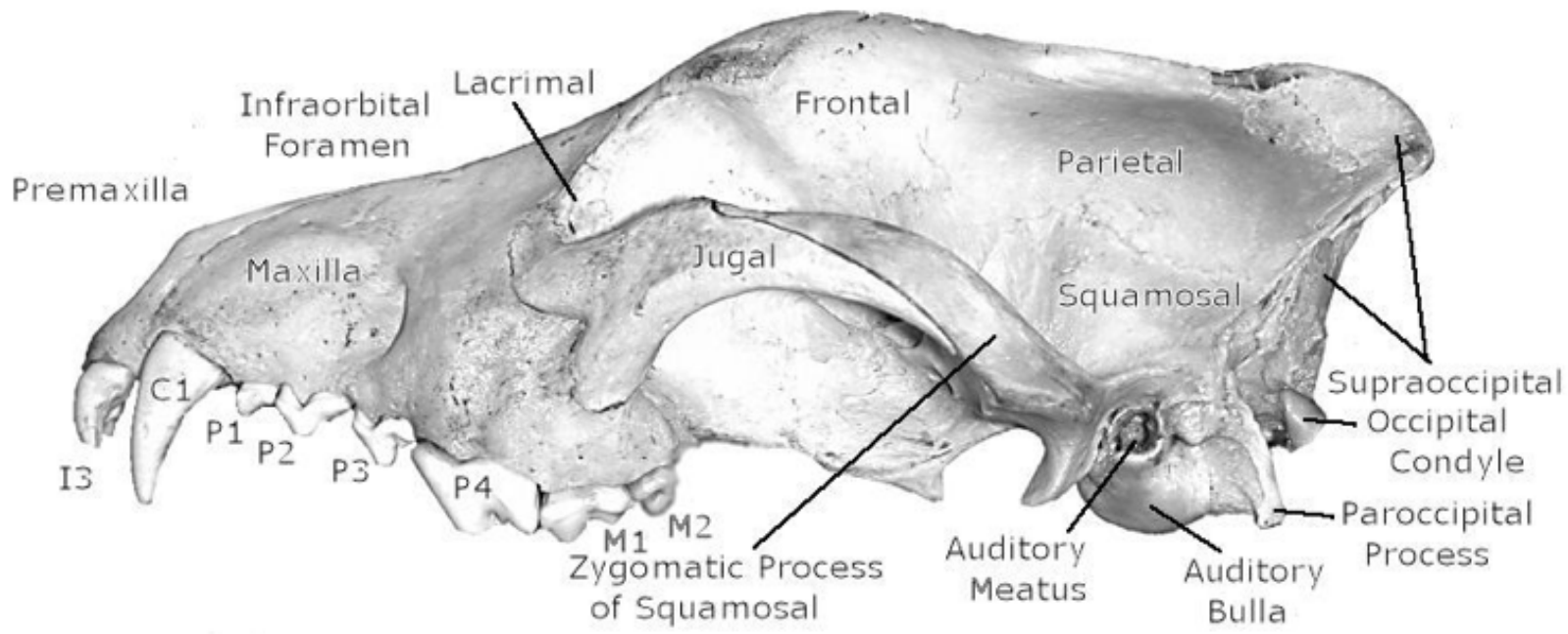
Lophodont teeth have fused cusps to form lophs or ridges. They are seen in herbivores, including many species of rodents, as the ridges create abrasive surfaces for grinding plant material

Selenodont teeth have ridges that are created by the lengthening of a single cusp with each ridge being crescent-shaped. This type of tooth is usually seen in herbivores such as deer, elk, caribou, and cattle.

Selenodont teeth

Mammal Skulls

The identification of a skull (species) can be determined by several methods. The use of a dichotomous key allows a person, through a series of questions, to identify an organism to species by process of elimination. Other measurements of the skull can be taken to help in this process. Common measurements include *Condylo-basal length* (from the occipital condyle to the furthest edge of the premaxilla) for the length of the skull, *zygomatic breath* (greatest distance between the outer edges of the zygomatic arches (or process)) for the width of the skull, and *nasal length* (distance from the edge of the premaxilla to end of the nasal bone) for the length of the nose.



In combination with the structure of the teeth, a mammal skull can tell you a lot about the diet and lifestyle of its owner. Above is a picture of a canid (carnivore) skull. Below are diagrams of some basic mammal skulls from major mammalian groups.

Beaver (Rodent) skull

Bat skull (note reduced incisors)

Shrew (Insectivore) skull

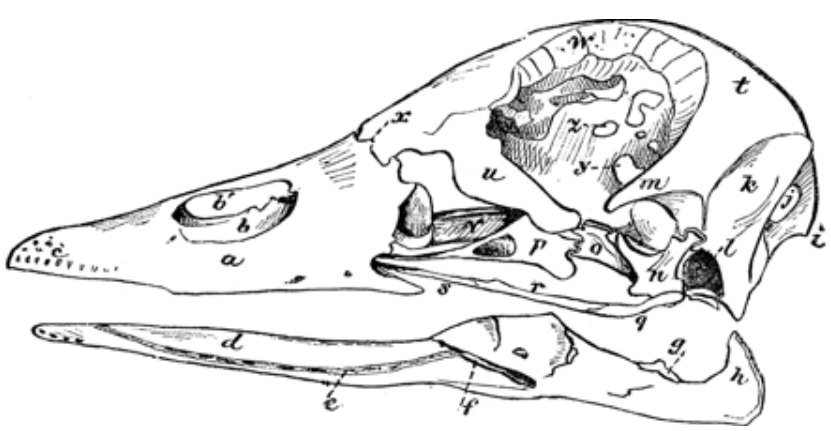
Beluga (cetacean) skull

Snowshoe hare (Lagomorph) skull

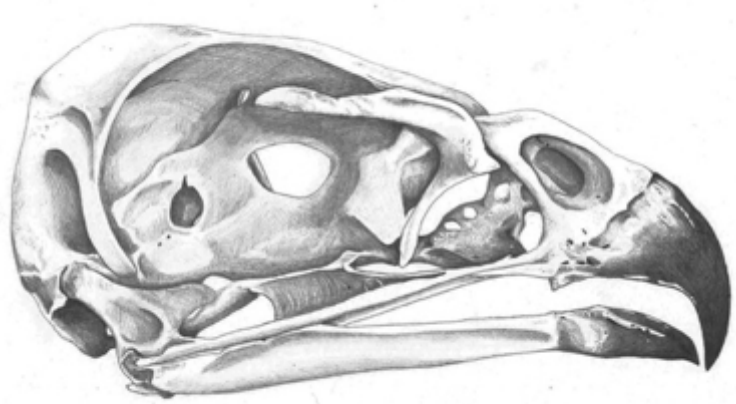
Moose (Artiodactyla) skull

Bird Skulls

The beak of a bird is an extension of its skull and is designed for feeding. Some beaks have evolved to specialize in feeding specific items. A duck, hawk, hummingbird and sparrow are all birds, but their beaks are very different due to their different diet. A duck has a wide flattened "bill" used for eating aquatic plants and mosses. A hawk has a sharp hooked beak used in tearing flesh from its prey or carrion.

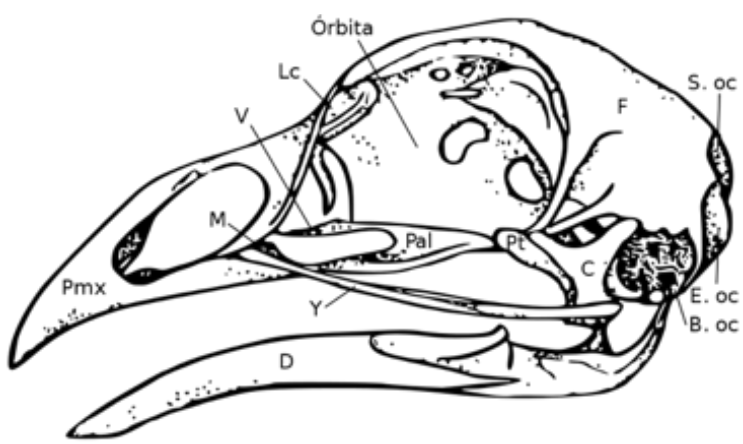


Duck Skull



Hawk Skull

A hummingbird uses its long narrow beak to lap nectar from flowers and a sparrow has a small powerful beak used for picking berries and cracking seeds. As you can see, a bird's beak can tell you a lot about not only the diet, but also the lifestyle of its owner.



Crane Skull

Hummingbird Skull

Horns and Antlers

Horns or antlers found on a skull bear evidence of how an animal communicated, defended its self and possibly the animals' sex. Animals can protect themselves or attack other animals by goring them with their horns or antlers. Bighorn sheep, muskox and deer use their horns or antlers for establishing territory and winning mates. Horns are permanent structures that grow year after year. Depending on the species, both male and female bovid animals (cattle, gazelle, antelope, etc.) can have horns. Antlers, however, are temporary. Antlers grow, develop and shed from the animal once a year. Antlers are branched and only found in the cervid family (deer, moose, elk, etc.). With the exception of the female caribou, only male cervids have antlers.

Bighorn Sheep with horns

White-tailed deer with antlers

ANIMAL ACCLIMATION AND ADAPTATION

Adaptation is any behavioural, morphological, or physiological trait that is a result of natural selection. This inherited characteristic should enhance an organism's ability to survive and reproduce in their environment. Some individuals, who often possess these adaptations, will leave more offspring than others. These individuals are considered to be more 'fit' than others because they contribute the most to the entire population's gene pool. Differences in the reproductive success of individual organisms come about through the process of natural selection. Under a specific set of environmental conditions, the individuals that survive the best or have adaptations to best survive those conditions are selected for. Any individuals that either do not have adaptations to survive and reproduce in these conditions or survive worse than others will be selected against.

Acclimation is the short-term response of an individual to different or changing natural environments. For many species, this acclimation occurs each season. For example, a fish inhabiting a pond in which the water temperature changes from summer through to winter. As the winter cools in fall and winter, the tolerance for low temperatures increases, while their tolerance for high temperatures decreases. Conversely, as the water warms during the spring, the tolerance of the fish for warmer temperatures gradually increases. Although their tolerance changes with the seasons all of this shifting takes place within the adaptive limits of the fish.

BASIC NEEDS AND ADAPTATION

All wildlife need to solve a common set of problems. They must obtain oxygen, nourish themselves, excrete waste products, and move.

Abiotic factors, such as temperature, water, sunlight, wind, rocks and soil, and climate all impact an animal's ability to obtain the resources they need to live and ability to survive in the environment. The temperature of an area affects all biological processes. The availability of water within regions affects species distribution as all species need water to survive and many species live within this water. Sunlight provides the energy that plants use to grow. As the primary food source, the abundance and distribution of plants in an environment will impact the abundance, density, and diversity of wildlife in a region. Additionally, the physical structure of rocks and soil limit the distribution of plants and thus the animals that rely on them. Climate is one of the biggest abiotic driving factors that influence the distribution of wildlife on earth. Climate influences the temperature of a region, availability

of water, sunlight, and wind, as well as the structure of rocks and soil. It also limits the biological process of all living organisms and thus plays a large role in dictating the diversity and abundance of wildlife.

Animals need to derive their energy from organic carbon compounds. All animals eat other organisms to stay alive. The ultimate source of these organic compounds is plants. More details about how animals obtain energy and the flow of energy through an ecosystem are discussed in Trophic Ecology.

Animals are required to obtain oxygen from their environment to stay alive. Groups of wildlife obtain this oxygen and distribute it through their bodies differently. Wildlife must take molecular oxygen (O_2) from their environment and release carbon dioxide (CO_2) back into the environment. The exchange of gases occurs on the respiratory surface. The oxygen must then be supplied to the entire body (through the circulatory system) and carbon dioxide removed. The structure of the respiratory surface depends on the size of the organism, its habitat, and its evolutionary past. Some animals, such as earthworms and some amphibians, use their entire outer skin as a respiratory organ. Gills, outfoldings of the body surface, are used by some aquatic invertebrates (e.g. sea stars, segmented worms, scallops, crayfish, etc.) as their respiratory surface. Tracheal systems are used in insects. The tracheal system is made up of air tubes that branch throughout the body. Lungs are a respiratory surface that is restricted to one location. They have a dense net of capillaries that form the main respiratory surface. They are present not only in mammals and birds, but other vertebrates, terrestrial snails, and spiders. The size and complexity of the lungs are correlated with the animal's metabolic rate. Further adaptation is seen within these basic respiration surfaces. For example, bird ventilation is much more complex than observed in mammals. The additional complexity increases the concentration of oxygen within the birds allowing them to fly at high altitudes.

An animal's size and shape are fundamental aspects of form and function that affect the way an animal interacts with its environment. Physical requirements constrain what natural selection can select for, including the size and shape of an animal. For example, physical requirements limit the size and shape of flying animals. An animal the size and shape of a mythical dragon could not generate enough lift with its wings to get off the ground. In contrast, a small hummingbird is light for its size and is well adapted to flight.

HABITAT AND SPECIALIZED ADAPTATION

Wildlife adapt themselves to the habitat in which they live. Specialized adaptation of each species to their habitat ensures their survival and continued ability to reproduce. This adaptation also allows species to survive predictable changes in their environment, such as the onset of winter or summer, or the wet or dry seasons.

Thermoregulation

Thermoregulation is the process by which animals maintain their internal temperature. Animals use different strategies to manage their "heat budgets". All of these strategies have both large benefits as well as costs associated with them.

Ectotherm – gain most of their heat from the environment. Many ectotherms regulate their body temperature through behavioural means, such as basking in the sun or seeking out shade. They include invertebrates, fishes, amphibians, lizards, snakes, and turtles.

Endotherm – use metabolic heat (from their body) to maintain or regulate their body temperature. Examples include mammals, birds, a few reptiles, some fish, and a few insect species. The maintenance of a constant body temperature is another adaptation that is seen in some animal species.

Pokilotherm – an animal whose internal body temperature varies widely. Examples include fish and invertebrates.

Homeotherm – an animal whose internal body temperature remains relatively stable. Examples include mammals and birds.

Although we generally think of all ectotherms also being pokilotherms (or 'cold-blooded') and all endotherms being homeotherms (or 'warm-blooded') there are many species that have different adaptive strategies. Many species of marine invertebrates and fish are ecotherms but because of their environment their body temperature remains relatively constant, making them homeotherms. Further, some mammal species experience large variations in body temperature through the year (e.g. hibernation) despite them being endotherms.

Animals have many adaptations to assist them with thermoregulation. They include insulation (e.g. hair, feathers, blubber, etc.), circulatory adaptations (e.g. vasodilation, vasoconstriction, countercurrent heat exchanger, etc.), behavioural responses (e.g. hibernation, migration, etc.), and adjusting metabolic heat production (e.g. brown fat).

Camouflage

Camouflage is the set of methods of concealment that allows otherwise visible animals to remain unnoticed by blending in. In many animal species, young are born with dappled brown coats so that they can blend into the brush or forest. The arctic fox and snowshoe hare change into a white coat during the winter period to blend into their snowy environment. They shed this winter coat in the summer period. It is replaced by a mostly brown coat.

Mirnesis is a type of camouflage where an animal resembles something else in its environment. For example (as seen in the photo to the top right), the stick insect mimics a stick, hiding itself from predators.

Crypsis is a type of camouflage where the animal means to be hidden. Cuddlefish (as seen in the photo to the bottom right) are very good at matching the colour and texture of their environment protecting them from predators. Many species of octopuses camouflage in the environment, allowing them to capture prey more easily.

Behaviour

Each animal species has unique behaviours that allow it to survive in its habitat. Examples include different social organizations, such as flocks or herds (geese, cranes, caribou, sheep, goats, elk, muskoxen, fur seats, walrus), family groups (eagles, wolves, whales, river otters, foxes, beavers), solitary life (moose, lynx, wolverines, porcupines), and colonies (many rodents).

Other adaptive behaviours are defensive strategies. For instance, muskoxen form a tight circle around the herd's young when threatened by predators. The adults face the outside of the circle, showing only their horny brows and front hooves.

Still other adaptive behaviours include hunting methods, such as wolves' pack hunting, killer whales' and humpback whales' circles of bubbles that trap fish, and bears' use of their long claws to swipe salmon from streams.

WILDLIFE AND WINTER

The ecology of wildlife and winter is an intricate web of seasonal changes and adaptations by animals to these changes. Temperature and snow are the two ecological factors that present problems to wildlife in winter. The degree to which animals can cope with these factors depends on behavioral, physiological, and morphological adaptations.

Many animals totally avoid cold winter temperatures by migrating, hibernating, or just sleeping. For some of these it is not the cold that directly causes this behaviour. Birds have very adequate insulating feathers, but many birds migrate. A bear has thick fur, which is also a good insulator, but bears sleep in warm dens most of the winter. Still, many other animals remain completely active in winter. What dictates whether an animal will migrate or stay? What influences whether an animal will hibernate, sleep, or remain active?

It takes more than good insulation to keep animals warm. They must have fuel to produce body heat. Energy, which most obtain through food, is the dictator. Cold temperatures kill or drive off much of the animals' food, or snow (caused by cold temperatures) covers their food sources.

Adaptations to Cold

All animals must have a means of regulating body temperatures. Thermoregulation, as this is called, can be divided into three categories: poikilothermic, homeotherm, and heterotherms (as defined in above).

Many homeotherms use torpor as a way to conserve energy when the temperature changes. **Torpor** is a state of decreased physiological activity in an animal, usually by a reduced body temperature and metabolic rate. Torpor enables animals to survive periods of reduced food availability. A torpor bout can refer to the period of time a hibernator spends at low body temperature, lasting days to weeks, or it can refer to a period of low body temperature and metabolism lasting less than 24 hours, as in "daily torpor".

Hibernation

Hibernation is a state of inactivity and metabolic depression in animals characterized by lower body temperature, slower breathing, and lower metabolic rate

True hibernators reduce their body temperature to near that of the environment, possibly to a few degrees above 0°C. Their metabolic rate may be reduced more than fifty-fold. Small mammals, the largest group of hibernators, have a very low body-mass-to-surface ration so they lose heat very quickly. Hibernation, therefore, is an excellent energy economy for them. Hibernators need to wake up every few weeks o eat small amounts of stored food and pass wastes. True hibernators include ground squirrels, chipmunks, and other rodents.

Hibernating ground squirrel
© Oivind Toien

Fatness seems to be related to hibernation because fat animals tend to start hibernating sooner than thin ones. However, fattening is not a necessity for thin animals of the same species may hibernate as well, although the onset may be delayed. Some hibernators do not fatten up in the fall but store quantities of food.

When entering hibernation the heart beat and metabolic rate decline before the body temperature starts to drop. This indicates that entering hibernation is an active process where vital functions are actually suppressed with the resulting decline in body temperature. The optimum environmental temperature for hibernation in most mammals is about 10°C. The body and environmental temperature are virtually the same in bats, while body temperature is two or three degrees warmer in ground squirrels. The respiratory rate drops to less than one cycle per minute, occurring in a series of two or three quick gasps followed by long rests. The heart rate may go as low as two or three beats a minute, but blood pressure remains quite high.

There are apparently limiting factors, which have prevented hibernation from becoming more widely established in the animal kingdom. The size-range of hibernators may be one such factor, from the smallest known hibernator, the bat, to the marmot, the largest known true hibernator. Within this size-range there seems to be a metabolic economy in the process of hibernation.

Daily Torpor

Many animals will lower their body temperature and metabolism for a shorter period of time (less than 24 hours) in order to save energy. Animals that undergo daily torpor include birds (even tiny hummingbirds) and some mammals, including many marsupial species, rodent

species such as mice, and bats. During the active part of their day, such animals maintain normal body temperature and activity levels, but their metabolic rate and body temperature drops during a portion of the day (usually night) to conserve energy. Torpor is often used to help animals survive during periods of colder temperatures, as it allows them to save the energy that would normally be used to maintain a high body temperature.

Dormouse in torpor

Seasonal Lethargy

Seasonal lethargy defined as profound dormancy when animal remains at a body temperature only 2-5°C less during the winter.

Black bears in seasonal lethargy

Not all animals are able to lower their temperature and their heart rate as much as true hibernators. Many larger animals, like bears, become more lethargic and sleep through much of the winter. The heart rate of a bear also drops, though not as rapidly. During the early part of its seasonal lethargy, a bear's heart rate averages 50 beats per minute. After several months of uninterrupted sleep, the rate may drop to as low as 8 beats per minute. But a bear's body temperature remains nearly normal during this period. That's the reason a bear can wake relatively quickly -- a fact that's resulted in more than one hasty exit by from a bear den researchers. Pregnant females wake in mid-winter to give birth, then go back to sleep while their newborn cubs nurse. Still, most bears sleep all through the winter if left undisturbed.

Acclimatization

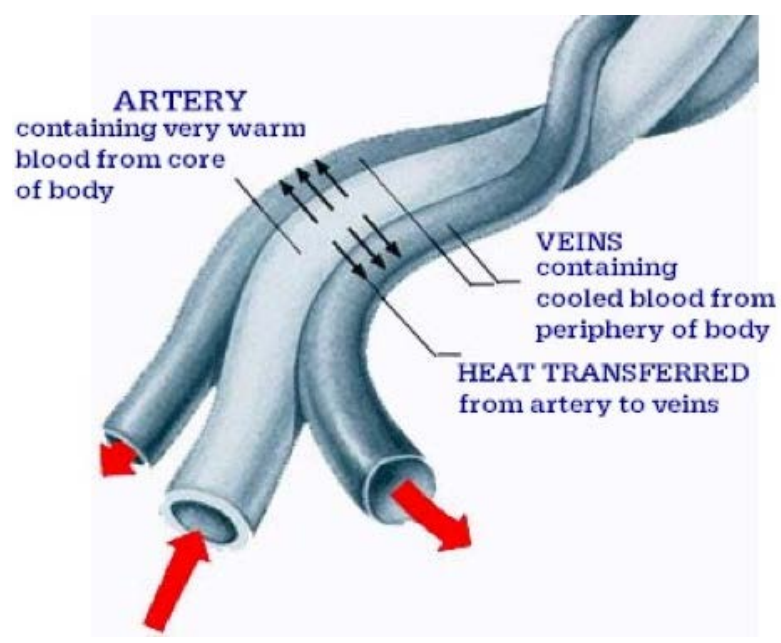
Homeotherms, that are not hibernators, precisely control their body temperatures. Many mammals control body temperature so well that there is barely any daily variation.

Many animals remain totally active during winter. They travel through or on top of the snow in search of food and to escape predators. What adaptations allow them to withstand cold winter temperatures? In the following discussion you will notice that some adaptations have

evolved to cope with both cold temperatures and snow. Cold adaptations (acclimatization) occur in three categories: behavioral, physiological, and anatomical.

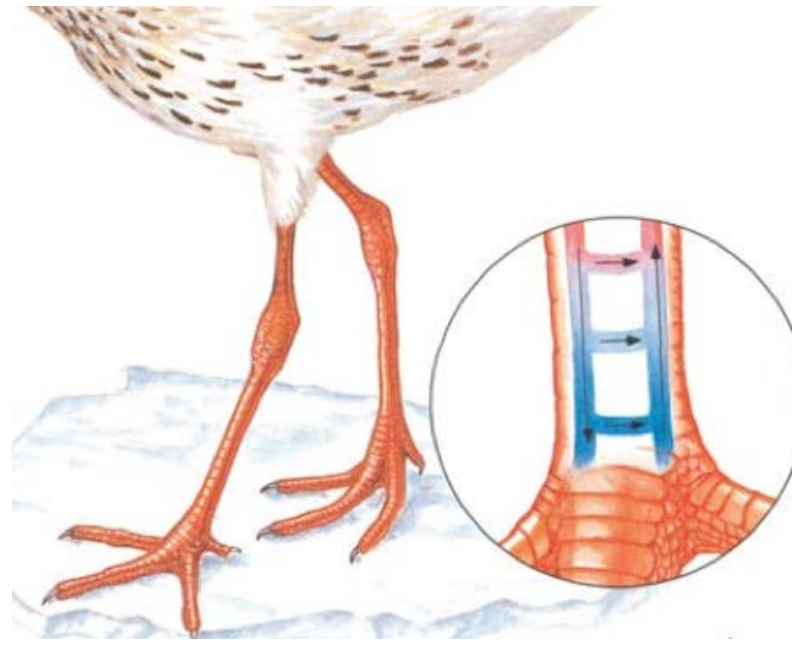
1. *Behavioral adaptation* – a large group of small mammals and many insects remain active under snow. These animals are known as chioneuphores, and their characteristics are discussed below in Table 1. The lifestyle that has evolved for them is called subnivean, and it affords them a constant temperature (rarely below 0°C) in which to move about in search of food. The beaver and the squirrel are both active in winter, one under the ice and one in the trees. However, these creatures have been busy during the fall storing food, which would otherwise be covered with snow or would be hard to obtain without wasting important energy (body heat). The beaver makes an underwater cache of leafy branches somewhere near the beaver lodge. At any time during winter a short swim under the ice to the cache to bring back a branch to the dry eating-platform in the lodge is all that is required. The squirrel has been busy during the fall collecting nuts and seeds and storing them underground or in hollows in trees within easy distance of its sleeping place. Beginning in the fall many animals increase their food intake, and many change their diets to food with higher energy content. Increased eating in fall is related to the occurrence of a physiological adaptation: an increase in the brown fat content of the tissues.

2. *Physiological adaptation* – More than other animals, mammals have been studied for their adaptations to cold temperatures. It is well known that shivering in mammals is not just an indication that an animal is cold but also a way of producing body heat. Muscle contractions in quick succession, as in shivering, produce body heat. However, with the full onset of cold temperatures shivering actually decreases and more effective heat mechanisms keep the animal warm. A second marvelous mechanism for heat conservation has evolved in the legs and feet of animals that need to withstand winter temperatures. Counter current heat exchange - Ever notice a duck standing on ice and wonder how there feet do not freeze while they spend the night sleeping on ice in sub-zero temperatures? The short answer is that it is about heat exchange. The smaller the temperature difference between two objects, the more slowly heat will be exchanged. Ducks, as well as many



Counter current heat exchange

other birds, have a counter current heat exchange system between the arteries and veins in their legs. As blood flows through the blood vessel and gets closer to the cold surface of the body, the warm blood loses heat to the surrounding tissues. The blood of the animal becomes cooler as it loses heat to the tissues. Enough heat is lost to the tissues such that when the blood gets very close to the surface of the body, there is a small temperature gradient. This smaller temperature gradient means that less heat is lost from the blood and tissues. When the blood leaves the body surface, it has a low temperature. However, the vessels carrying blood to, and away from the surface are very close to each other (see above). These vessels are close enough that when warm blood loses heat, the returning cold blood picks up the heat and increases in temperature. As cool blood moves further into the body, at each stage, the warm blood losing heat is always warmer then the cold blood, and so heat is constantly transferred to the cool blood, increasing its temperature. This exchange of heat works because the warm blood is always slightly warmer than the cold blood, and heat will travel down this gradient. Counter current heat exchange prevents the loss of a large amount of heat by causing the transfer of heat from warm blood, to cool blood re-entering the core of the body. This prevents a large loss of heat across the body surface and prevents extremely cold blood from entering the core of the body and dropping the core body temperature.



Heat-exchange in birds

3. *Anatomical adaptation* – The change for winter that you are most likely to be familiar with is the thickening of insulation, the fur. Many mammals grow a thick soft under fur covered by the normal, longer coarse over fur. Many mammals grow a thick soft under fur covered by the normal, longer coarse over fur. If you can, watch and inspect this cycle of change in a dog such as a Siberian husky and you will see this happening. Birds experience an increased thickness or loft of feathers, which they can lift away from their bodies to increase their insulation. Some mammals have evolved more compact smaller ears and feet so that less heat is needed to keep these extremities warm. A general higher tolerance to cold stress-which is difficult to measure- also occurs in water-active animals.

Adaptations to Snow

The depth, the density (compactness) and the hardness (moisture content/temperature relationship) of snow on the ground are factors that influence wildlife. Shelter, travel, food and escape from predators are the essential requirements for wildlife in winter. Snow presents problems to wildlife in their pursuit to satisfy these requirements. Some biologists use an ecological classification to indicate how animals have adapted to cope with these problems. Adaptations may again be behavioral, physiological, or anatomical, as were adaptations to temperature. The classification is intended only as a set of guidelines. Certain animals overlap the lines of this classification and cannot be rigidly classified. Only a study of the specific adaptations to snow will provide a relative classification for the animal.

The ecological classification of animals' adaptations to snow

Class/adaptation	Behavioural
Chionophores	
Avoid snow	*Migration*: birds, insects, small mammals
Venture out infrequently	*Hibernation/Dormancy*: insects, snakes, frogs, ground squirrels
	Store Food/Sleep: tree squirrels, beaver, bears, skunk, porcupine
	Anatomical
Chionophiles	
Snow lovers Do not avoid snow Have adaptations	*Floaters*: ptarmigan, hare, lynx. Floaters are elevated to new supplies of food every snowfall. This adaptation relies on density and hardness of snow. Birds like the ptarmigan grows compact flexible feathers around each toe. Hare and lynx also grow dense hair on their feet. Their gait (type of movement) aids in snow travel. If snow is not dense and hard, even a snowshoe hare may sink slightly and experience some difficulty in travelling. This adaptation would be essential to escape from predators or in pursuit of prey.
	Pelage changes: white hair grows in and dark hair is shed due to little understood influences of light intensity and temperature (snowshoe hare, ermine, ptarmigan). Camouflage is important to both predator and prey
Chioneuphores	
Do not avoid snow Do not have specific adaptations for snow but carry on as normal	*Ploughers*: moose, deer, elk, wolf, fox. These animals travel where snow is shallower or along trails packed by game. Hard and dense snow allows easier travel for some on top of snow (wolf). If there is a crust deer and moose may punch through continually, making them easier prey for wolves.

Class/adaptation	Behavioural
	Burrowers: shrews, moles, and voles. They remain completely active under snow where the temperature remains warm and moist relative to snow surface temperatures as they could not withstand cold temperatures. Because of carbon dioxide build up under snow, these animals must dig ventilator shafts to the surface. Snow that is too hard or dense may cause a problem for ventilation.

Behaviour in Winter

Non-avian Reptiles

Reptiles, such as snakes and lizards, are poikilotherms that produce relatively less metabolic heat than homeotherms. With no effective surface insulation such as hair or feathers, and little subdermal fat, their body temperature depends on the temperature of their immediate surroundings and what heat they can absorb from the sun's rays. Unless there is an external source of heat such as sunlight, temperatures below that at which ice forms in their tissues can quickly kill most poikilotherms. Thus all poikilotherms in this area must hibernate or find an alternative coping mechanism and they must doe this in a sheltered place. The red-sided garter snak is particularly interesting. Not only is it the most common reptile in Manitoba, but also it lives farther north than any other reptile on this continent.

Despite the various mechanisms this snake has evolved to survive the winter, there still appears to be a high degree of overwintering mortality. Perhaps many of the snakes don't get deep enough underground to avoid freezing. Or perhaps many die from lack of oxygen. We may never know.

Insects and Invertebrates

Insects employ four main ways to survive winter. Firstly, some, such as the monarch butterfly, migrate. Secondly, some enter diapause, which is dormancy deeper than sleep. This may happen at any stage of the insect's life cycle. Adults may seek shelter in crevices in trees, rocks, and buildings. These adults in diapause secrete glycerol, a biochemical that acts as an anti-freeze and prevents damage to tissues from freezing.

Thirdly, on branches you may find galls and cocoons in each of which an insect is changing from one stage in its life cycle to the next. Many insects lay eggs in late summer. These can be found on twigs or in pond water, and can over-winter without freezing until they hatch in spring. Fourthly, many insects remain active under the snow in winter. In warm moist conditions these invertebrates are active in obtaining food from the leaf litter. Snow cover in Manitoba creates a subnivean microenvironment at the ground surface, which is very

different from the above-snow macroenvironment. Temperatures under the snow may hover between 0°C and -6°C in spite of the coldest above-snow temperature.

Birds

Many people regard winter as a time of year when there are few birds in Manitoba. This is not necessarily true, however, as at least 30 species are regularly found in the province, but many of these are localized within restricted ranges. The Goshawk is the only hawk regularly found in southern Manitoba in the winter. It feeds on whatever mammals or birds are available and which it can catch. Ruffed Grouse and Snowshoe Hare are amongst its favored foods and are readily taken despite their large size. The Goshawk is associated with dense woods and can frequently be seen winging its way down narrow valleys and along shorelines.

The Ruffed Grouse – a bird of the thick woods – feeds in the early morning and at dusk, and at these times can be observed perched in a tree eating buds of poplar, birch, willow, or spruce. During the remainder of the day, they roost in dense thickets or under snow. At night, if there is little snow, they roost next to the trunk on the lower branches of a tree. If the snow is deep, they fly into the soft snow and form a cavity as much as two feet below the surface. Here they are insulated from drifting snow, icy winds, or sub-zero temperatures. In agricultural areas, Sharp-tailed grouse can best be seen during the morning, feeding in stubble fields. Sharp-tails spend the night sleeping in tall grass until the snow becomes deep, then they are forced to bury into snowdrifts along the edges of woods.

The White-breasted Nuthatch is regularly found at many feeding stations where suet, acorns, and sunflower seeds are the favored foods. This bird roosts overnight in a sheltered cavity, which is the center of its winter territory.

TROPHIC ECOLOGY

Trophic ecology is the study of how energy moves through an ecosystem. All organisms must obtain energy for their growth, survival, and reproduction. The methods of obtaining these resources and the impacts of resulting interactions are all studied within trophic ecology.

Autotrophs – organisms that use inorganic sources of carbon and energy from solar radiation. Examples include plants, algae, and certain bacteria. They are also known as PRIMARY producers.

Heterotrophs – organisms that use organic sources of carbon by consuming other organisms or their by-products. Examples include animals, bacteria, and fungi. They are often referred to as SECONDARY producers.

> **Consumers** – these are heterotrophs that consume other organisms
> **Decomposers** – these are heterotrophs that consume dead organic matter or waste products

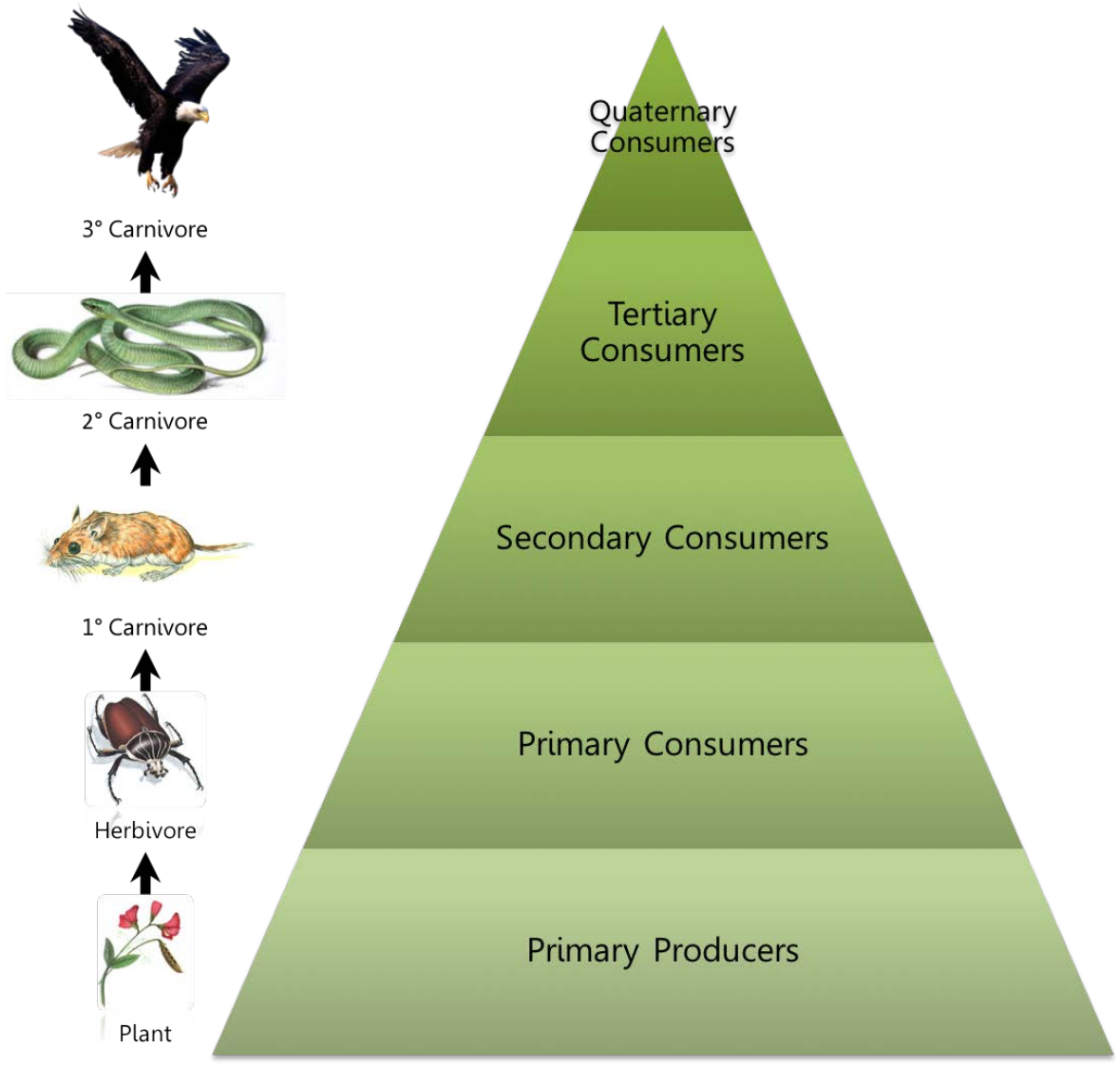
Herbivores – organisms that primarily consume plant materials. They include grazers (feed on leafy material like grasses), browsers (feed on woody material), granivores (feed on seeds), and frugivores (feed on fruit).

Carnivores – organisms that are 'flesh-eaters'. They consume herbivores or other carnivores. Individuals that feed directly on herbivores are considered first-level carnivores (second level consumers). Individuals that consume both herbivores and first-level carnivores can be considered second-level carnivores (third level consumers).

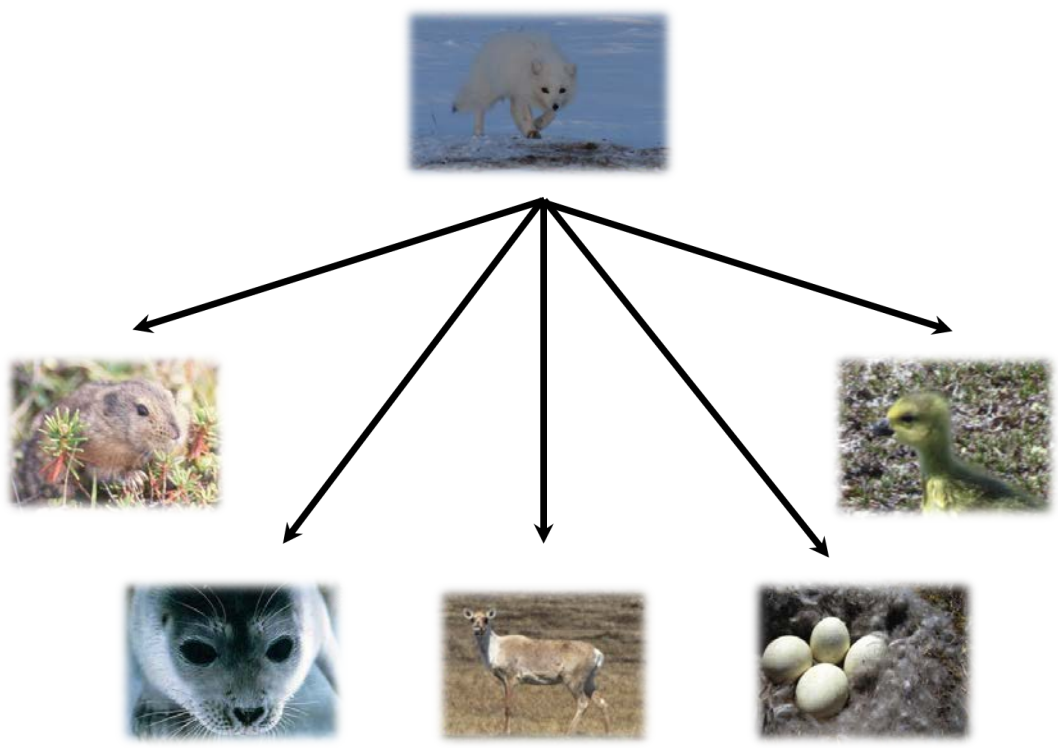
The trophic level is a stem in the transfer of energy, or food, within a food web or chain. There may be several trophic levels within a system, including primary producers, primary consumers, and secondary consumers. Further carnivores may form fourth and fifth levels. Primary producers are the most abundant food source and biomass (mass of organic material) available. Primary consumers, who consume primary producers, are the second most abundant group of organisms. Tertiary and quaternary consumers represent the smallest groups of organisms. The amount of energy in each a trophic level is reduced with every step up.

Many species can feed on different trophic levels. For example, the red squirrel often will consume acorns or fruits, primary producers, and so it acts as a primary consumer. However, red squirrels can also consume insects or nesting birds. When they consume these prey sources they are acting as secondary consumers.

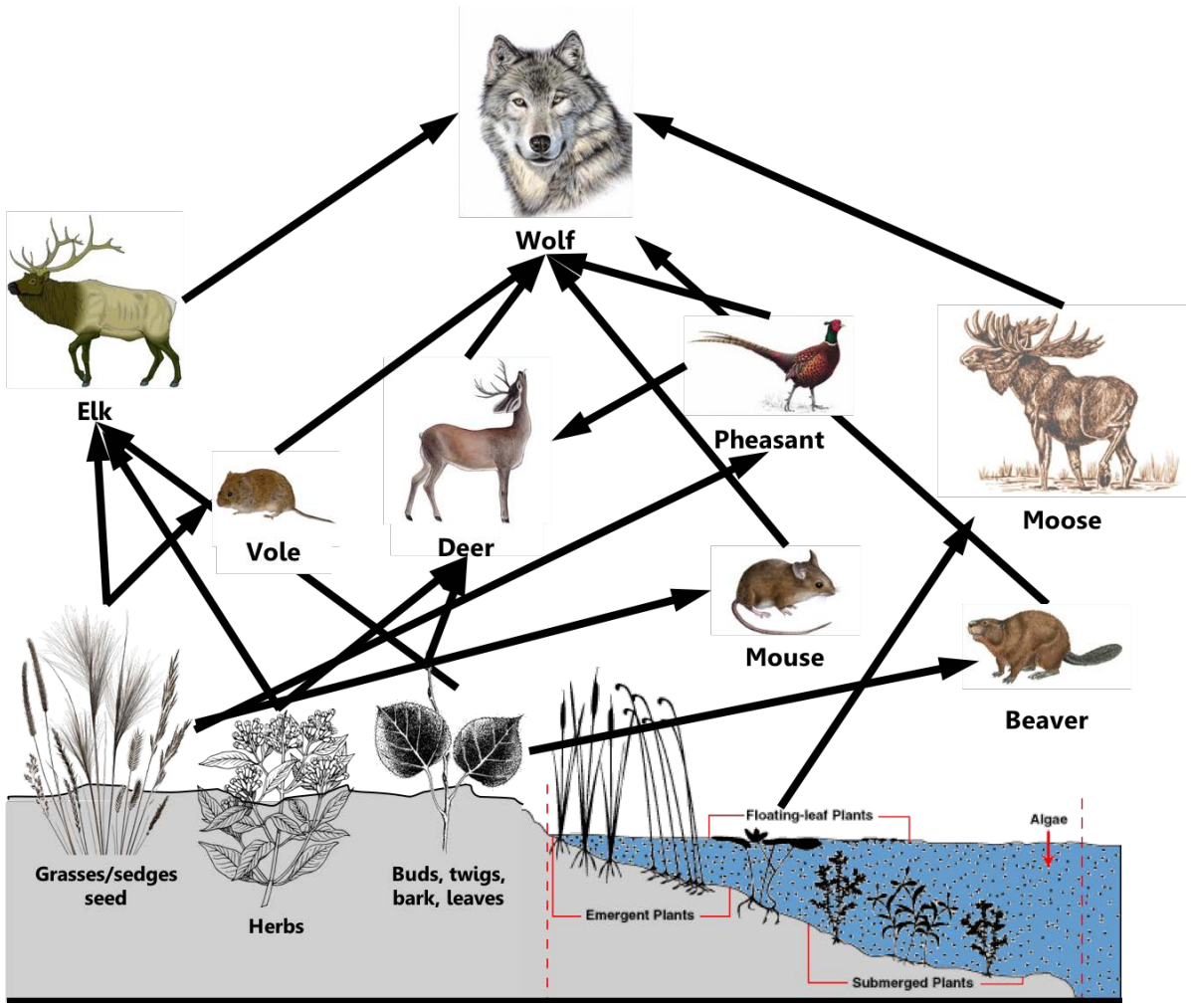
Most food webs are interconnected. Animals typically consume a varied diet and, in turn, serve as food for a variety of other species that prey on them. These interconnections are very important for the structure and diversity of an ecosystem.



For example, below is a simple food web of the diet of an arctic fox. It can consume a variety of different items that all come from different trophic levels.



The arctic fox consumes lemmings (primary consumers), caribou (primary consumers), goslings (primary consumers), as well as seals (secondary or tertiary consumers). Food webs can get much more complex. For example is a boreal forest food web:



Note that even though this food web may seem complex it is missing many species that are important including, but not limited to, insects, arachnids (spiders, ticks, mites), many species of parasites (including cestode (tapeworm), nematodes, trematodes (flatworms)), fishers, weasels, foxes, and many species of birds (especially song birds and raptors).

PATHOGENS, PARASITES, AND DISEASE IN WILDLIFE

Every living organism has parasites and wild animals are no exception. Parasitism is the most common consumer strategy and can impact the ecology and evolution of all interactions. Parasites have coevolved with the animals which host them, and they can strongly influence ecosystem dynamics. Increasing interactions between wildlife, livestock, and humans have been observed due to globalization of society, human population growth, and human-caused landscape changes. This facilitates increased transmission of zoonotic parasites. Understanding the impact of pathogens on wildlife is key to a broader knowledge of how an ecosystem functions. A good knowledge of the system is important in making management decisions about how we can mitigate these interactions.

Below is a brief overview of the key terms related to pathogens, parasites, and diseases. Some of the most common and important pathogens that impact wildlife are also described. Each description will also give you a brief introduction on how this pathogen is impacting the ecosystem in which it is found and management issues.

IMPORTANT TERMS

Parasitism – an interaction of species populations in which one (typically smaller) organism (known as the parasite) lives in or on another (known as the host). Parasites come from a wide variety of animal groups, including but not limited to viruses, bacteria, platyhelminths (flatworms), nematodes (roundworms), and arthropods (ticks, lice, fleas). The parasite obtains food, shelter, or other requirements from its host. A predator obtains energy by killing their host (living on the capital) whereas a predator does not (living on the interest). Parasitism generally implies some harm to the host, but this is often only observed with the addition of other stressors on the host. The effects of the parasite on the host may range from nothing to severe illness and eventual death. The effects of the parasite may vary by species or even individual. Parasites can be obligate (only live as a parasite) or facultative (may live as a parasite or independently).

Ectoparasites – parasites that live externally on the host

Endoparasites – parasites that live within the host

Pathogen – any parasite (e.g. virus, bacteria, nematode, platyhelminth, etc.) or prion that causes disease

Disease – an abnormal condition which affects the body of an organism. It may be caused by an external source such as a pathogen (i.e. parasite) or internal dysfunctions (e.g. autoimmune diseases).

Zoonosis – A pathogen that can be transmitted from animals to humans and vice versa

PATHOGEN EXAMPLES

Borrelia burgdorferi (Lyme disease)

Borrelia burgdorferi is a bacterium that causes the illness, lyme disease. It is spread through the bite of Ixodes ticks (which by themselves are ectoparasites). The Ixodes ticks, also

known as deer ticks, most often feed on the white-footed mouse, white-tailed deer, and certain other mammal hosts.

Tick on human skin

Symptoms: Symptoms in humans occur in three stages: (1) distinctive red rash at site of tick bit (erythema migrans) (2) Fatigue, chills and fever, headache, muscle and joint pain, swollen lymph nodes, and skin lesions (3) joint pain (and arthritis), meningitis, Bell's palsy, irregular heart rhythm, depression, memory problems, sensation of numbness. In dogs it commonly presents as arthritis.

Hosts: White-tailed deer, humans, dogs, livestock, and other endotherms

Treatment: Antibiotics (Doxycycline)

Management Concerns: Ticks live varied habitats, including wooded regions and open edge habitats. They become infected when they feed on mice or other small animals (that can carry the bacteria). The bacteria are then spread to other hosts which may include other wildlife, humans, livestock, or pets. As white-tailed deer are one of the important hosts in this parasite lifecycle, increased movement of white-tailed deer in to urban areas may increase exposure to pets and humans. Further, if the range of white-tailed deer overlaps with those of livestock, it may increase the risk of infection in the livestock.

Red fox are important in reducing the prevalence of *B. burgdorferi* in a region. As an important predator of white-footed mouse, the red fox is key to keeping their population down. By reducing the white-footed mouse, an important host for Ixodes ticks and the transmission of the bacteria, the red fox reduces the prevalence of *B. burgdorferi* in the area.

Bovine Tuberculosis

Bovine tuberculosis (TB) is a disease caused by the bacteria *Mycobacterium bovis*. It usually infects the lungs, but it can infect the kidneys, spine, and brain. It is transferred between hosts through direct contact, contact with excretions, and inhalation of aerosols.

Symptoms: Cough, weight loss, and weakness

Hosts: Deer (white-tailed deer and mule deer), elk, cattle, llamas, pigs, cats, carnivores (fox, coyotes, wolves), mustelids, rodents, and humans

Treatment: None

Management Concerns: TB is a contagious disease that can be transferred from wildlife to livestock, such as cattle. In some regions where there is large amount of accessible feed that is used by both livestock and white-tailed deer or elk, infected saliva can contaminate the food and TB can be transferred from one host to the other.

Chronic Wasting Disease

Chronic wasting disease (CWD) is a prion disease that affects many species of cervids (e.g. deer and moose). Prions are abnormally folded proteins that resist all attempts to be broken down. The transmission route of CWD still unknown.

Deer with CWD

Symptoms: Behavioural changes (hyperexcitability, nervousness, decreased interactions, listlessness, lowering of the head, and repetitive walking in set patterns)

Hosts: Mule deer, white-tailed deer, Rocky Mountain elk, and moose

Treatment: No treatment, fatal disease

Management Concerns: CWD is a fatal disease that affects many species of cervids. It is of major concern to hunters and wildlife managers as it has the potential to substantially decrease cervid populations. Further, as the transmission route is still unknown it is difficult to manage the spread of the disease.

Echinococcus spp.

Echinococcus spp. is a tiny species of tapeworm that is transmitted trophically (through the food web) from an intermediate host (species of ungulate or small mammal) to a definitive host (species of carnivore) back to an intermediate host

Echinococcus multilocularis
© Alan R. Walker

and the cycle continues. *Echinococcus* is commonly transmitted between wolves and moose. In the wolf the tapeworm lives in the intestine (endoparasite) and is transmitted to the moose through the accidental consumption of the wolf feces. In the moose the tapeworm lives in cysts (cavity containing a liquid) in the organs (such as lungs). It is passed to the wolf when it eats the moose.

Symptoms: In moose, cysts occur most frequently in the lungs. It reduces the moose's ability to run away from predators, increasing their chances being killed. Organ damage can occur in the intermediate host. Weight loss may occur in the definitive host if the infection is large.

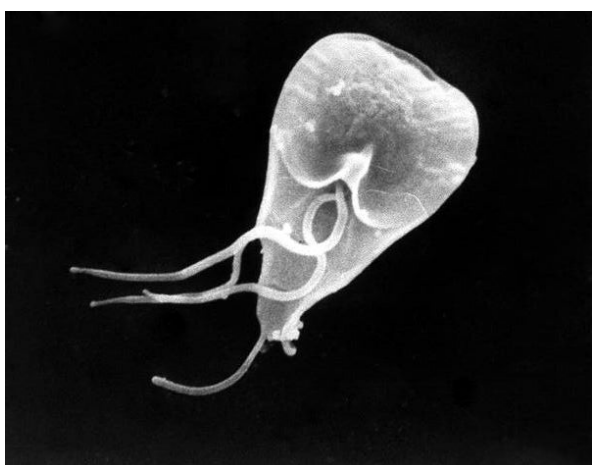
Hosts: Carnivores (wolves, coyotes, foxes, cats, hyenas), ungulates (white-tailed deer, moose, caribou, elk), small mammals (mice, voles, and rats) and accidental hosts such as humans

Treatment: Surgery to remove cysts

Management Concerns: Overlap with wild canids (e.g. wolves, coyotes, or foxes) can lead to transmission of *Echinococcus* spp. to accidental hosts (through contaminated feces) which can cause cystic *echinococcus*. The accidental hosts may include livestock (e.g. cattle, goat, etc.), pets (e.g. dogs, horses), and humans. The development of cysts in organs can cause damage and the rupture of this cyst can cause an allergic reaction and death. Alveolar *echinococcus* is another disease caused by infection by *Echinococcus multilocularis* which is much more serious. It can infiltrate entire organs, including the brain.

Giardia lamblia

Giardia lamblia is a protozoan parasite that causes giardiasis, which is also known as 'beaver fever'. It is found on surfaces, or in the soil, food, or water that has been contaminated with feces from infected animals.



SEM of *Giardia lambda*

Symptoms: Diarrhoea, flatulence, abdominal cramps, nausea, dehydration, weight loss

Hosts: Beavers, dogs, cats, sheep, cattle, and humans

Treatment: Prescription drugs

Management Concerns: *Giardia* is a zoonotic parasite that can be transmitted from wildlife to humans, humans to wildlife, wildlife to livestock, etc. Although it is rarely fatal, it can cause severe dehydration in some infected hosts.

Rabies Virus

The rabies virus is transmitted through the saliva or nervous tissues of an infected animal. Rabies is usually transferred when an infected animal bites another animal. Since it is transmitted by exposure to infected saliva, if infected saliva gets into a cut, wound, or a mucosal membrane (e.g. nose, eyes, or lining of mouth) an animal can become infected.

Symptoms: Irregular behaviour (increased aggression, depression, lethargy, lack of fear), paralysis (muscle weakness) particularly in the hind legs or throat, and excessive drooling

Hosts: Humans, domestic mammals (e.g. pets (cats, dogs, etc.), livestock), and wild animals (e.g. skunks, foxes, bats, etc.)

Treatment: Vaccinations pre- and post- exposure if treated before symptoms set in. Once an animal (including a human) is symptomatic no treatment is available. A few humans have been able to survive due to some novel treatments but this is rare.

Management Concerns: Rabies virus is a zoonotic pathogen that can be very dangerous for humans and their pets. One should avoid contact with wildlife or handling wild animals. Appreciate them from a distance. If you find an animal, such as a bat, skunk, fox, or raccoon, dead or alive, do not touch it with your bare hands.

White-nose syndrome

White-nose syndrome (WNS) is a disease caused by the fungus, *Geomyces destructans*, which appears on the muzzle and other body parts of hibernating bats. Little is known about how it is transferred between hosts.

Symptoms: Uncharacteristic behaviours (e.g. flying out during the day, clustering near the entrances of hibernacula)

Hosts: Bats

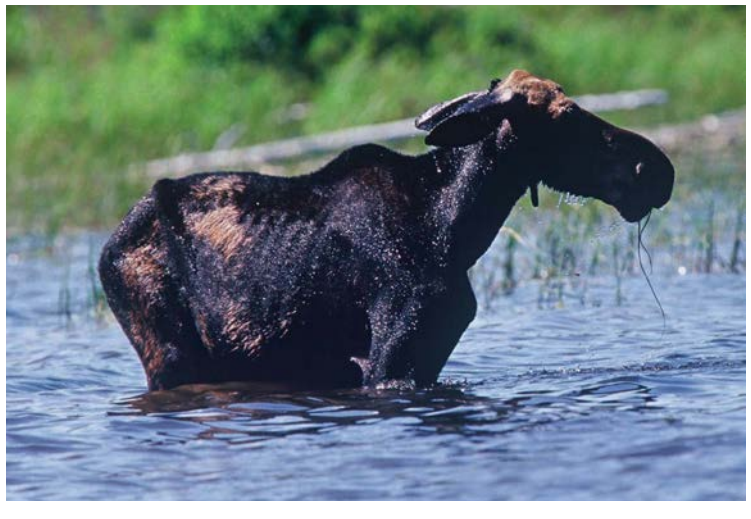
Bat with White-nose syndrome
© New York Environmental Conservation

Treatment: None

Management Concerns: WNS has been associated with extensive mortality of bats in primarily eastern North America. It was first documented in the winter of 2006-2007 and has spread rapidly. It has killed more than 6.7 million bats in eastern North America and in some hibernacula (areas where bat colonies hibernate during the winter) between 90-100% of the bats have died. Researchers are still trying to figure out how it is transmitted and how to control its spread.

Winter Tick (*Dermacentor albipictus*)

Winter tick, also known as moose tick or elk tick, takes a blood meal from its host (mostly ungulates) while attached. The engorged tick then detaches itself from its host and falls to the ground. They attach to their hosts during the winter and usually detach in early spring. If only a few ticks infest a host, such as a moose, then the moose does not suffer any disease. It is only when (on average) over 30 000 ticks are present that disease sets in.



Moose with winter tick
© Susan C. Morse

Symptoms: Loss of hair and very poor body condition (emancipated)

Hosts: Moose, caribou, elk, cattle, white-tailed deer, mule deer, bison, horses

Treatment: Grooming to remove the ticks

Management Concerns: Winter tick can cause mild to severe disease in moose, caribou, and elk. It can substantially reduce their survival through the winter. High infestations with winter ticks appear to increase the amount of energy the host requires and cause the host to starve.

ECOLOGY AND WILDLIFE MANAGEMENT

Wildlife conservation and management is the protection and use of wild-animal populations and of the land necessary to support them to ensure that productivity and ecological balance are maintained in perpetuity, while social benefits are realized. Human activity has become one of the most significant influences on the abundance and well-being of wildlife.

The over exploitation, or misuse of wildlife as a resource, has a long history in Canada. Wildlife, fish, and timber were previously free for the taking for personal use, or could be converted into a monetary return. In the early 19th century this attitude had removed elk from their eastern most limits near Ontario. The bison previously numbered in the millions across the North American plains. By 1885 they were almost gone. The extinction of the previously abundant passenger pigeon was the driving force behind the passage of wildlife conservation laws. The development of national parks, such as the Banff National Park (1885) created areas that protected wildlife and provided them with areas in which they could prosper. Various treaties have been signed (e.g. Migratory Birds Convention Treaty of 1916) in hopes of protecting the remaining wildlife.

While many forms of wildlife are more abundant now than they were in 1870, a number of species have continued to decline to threatened levels or are in danger of extinction. Wetland drainage permanently removes the habitat required by many species. Pollution of rivers and estuaries renders them unfit for wildlife survival. Acid rain from industrial effluent stacks, automobiles and urban areas continue to sterilize vast tracks of land and waterways in Canada. Marine birds and mammals increasingly face the threat of offshore oil spills and general pollution of the oceans. Recent and continued changes in the climate have already started to impact wildlife populations, particularly in the Arctic.

The uses and value of wildlife to society vary. Wildlife is one part of the equation which, together with vegetation and the abiotic environment, establishes the "balance of nature", the set of complex natural processes on which human survival depends. Wildlife is a direct source of food and other products for many Canadians. The value is most apparent in northern regions, but it is also important in southern Canada. Coastal and inland commercial fishing, based on naturally reproducing populations, is an important industry. The wild fur industry provides a direct source of income for thousands, representing the highest continuing economic return of any resource in mid-northern regions. These harvest uses not only give direct economic return but, provided their management is biologically

sound, also keep populations in balance with their food supply. It helps prevent overpopulation and dramatic losses from starvation and disease.

WILDLIFE MANAGEMENT TECHNIQUES

Wildlife management is the practical application of ecological principles to ensure the survival of all animals. Present wildlife management efforts focus on the conservation and continued existence of ideal numbers of wildlife. Wildlife managers use several approaches to arrive at these goals including:

1. Research: In order to exert careful control over the amount taken and methods used in the harvesting of wildlife, wildlife managers need a great deal of information about wildlife populations. Most importantly, they need an estimate of the number of animals in the hunted population, and the number taken each year.

2. Monitoring: Estimating the number of animals present is called inventory. Biologists use aerial surveys to inventory most large wildlife species. When leaves have fallen from the trees and snow is on the ground, dark animals like moose are easy to see from the air. The animals may be counted and classified on sample plots or entire winter ranges. More examples of techniques used to monitor populations are discussed in the Wildlife Research Methods Section

3. Refuges: Refuges provide safe areas for animals to live. For example, refuges provide safe areas during staging periods, restrict hunters access to staging waterfowl, eliminate the potential for hunting related accidents near urban centers and high non-consumptive resource user areas like Birds Hill Provincial Park and critical habitat areas.

4. Management Areas: Wildlife Management Areas are designated lands created within an agency's jurisdiction and in some cases, these areas are managed separately. They may be based on habitat, species, remoteness, hunting pressure or any other factor which managers feel requires a certain area to be managed separately. By breaking a larger area into smaller management areas, biologists can better gauge population levels, habitat conditions, hunting pressure, etc.

5. Seasons and bag limits (for hunting and harvesting): The ability to set seasons and bag limits is an important part of managing wildlife populations. A season, in this context, is the time period when a particular species may be hunted. Seasons and bag limits are set only after considering all factors affecting that population. If a wildlife manager feels a

need to increase or decrease a particular population, seasons can be lengthened or shortened to help reach the desired number. Seasons also help protect animals during critical breeding stages.

6. Habitat management and conservation: Habitat is the combination of soil, water and plants, commonly called 'cover' in which wildlife exists. The relationships between soil, water, plants and the species of wildlife dependent on them are many and varied. Humans and their activities can cause profound and often irreversible changes to habitat, usually to the detriment of wildlife. In order to maintain productive wildlife habitat, planning programs concerning man's use and the future of habitat components are necessary. Both short- and long-term planning for use of our land and water resources must include a recognition of the need to maintain suitable habitat if wildlife is to continue to flourish.

7. Hunting and trapping: Regulated hunting and trapping also make it possible to harvest animals when populations are at, or close to, their highest numbers over the year. Hunting and trapping remove a portion of the annual surplus before it is lost to "natural" causes. This is called the "harvestable surplus". Regulated hunting has never led to the extinction of a wildlife species or caused any species to become rare or endangered.

8. Public Education: Public understanding, acceptance and support are essential if wildlife management programs are to be successful. This will only happen if people are educated about wildlife and its needs.

9. Compliance (Laws): The creation and enforcement of wildlife laws is an important management tool. To be effective, these laws must be flexible to cope with changes in wildlife populations, habitats and the needs of people; they must be based on biological fact and complement other management practices. For example, a hunting season is a law enforced by Conservation Officers. Wildlife managers set the season based on sound biological information and in the best interests of the wildlife species. In cases involving rare or endangered species or sensitive breeding sites, complete protection from harvesting may be required. Conservation Officers enforce laws related to sex-specific licence types, not simply to be difficult but rather to support the concept of selective harvest, a sound, beneficial wildlife management practice.

10. Cooperative, co-management or joint management agreements: Formal Agreements and joint management agreements have been used by Manitoba and other governments like First Nations and conservation organizations to manage wildlife and wildlife habitat.

Examples of this are: The Waterhen Wood Bison re-introduction agreement between the Waterhen First Nation and government of Manitoba has resulted in the successful reintroduction of wood bison into Manitoba.

11. Species re-introductions: Reintroduction of wildlife species has been used where a species became extinct within Manitoba or parts of Manitoba. Successful reintroductions include the Waterhen wood bison initiative where sixteen wood bison were released to the area. There are now over 120 free roaming bison in Manitoba. Another excellent example of this management technique is the reintroduction of elk into the Interlake region.

PROBLEM WILDLIFE

Human-wildlife conflicts can occur when people and wildlife compete for resources, whenever you're living, working or pursuing recreational activities. Wild animals in inappropriate locations can pose significant problems for or threats to humans, other animals, or the environment. They can cause serious damage to crops, livestock and property. They can create hazardous conditions for vehicular traffic. They can expose humans and pets to pathogens leading to disease and health issues. Below we will discuss some of the problem wildlife found in Manitoba and the conservation and management issues surrounding these populations.

White-tailed Deer – White-tailed deer are one of the most abundant and easily seen big game species in Manitoba. Cities and towns have many natural areas that help support these deer in an urban setting. The deer do well with abundant food, shelter, and protection from natural predators. Bylaws also prohibit the hunting of deer within city limits.

White-tailed deer can cause damage to gardens, shrubs, fruit trees, and other public and private property. They can become a treat to human health and safety when they move onto roadways and collide with vehicles. They also are suitable hosts for deer ticks, which can transmit Lyme disease to other animals, pets and humans.

Managers ask people not to feed deer. Feeding the deer helps maintain artificially high populations, making the deer more susceptible to starvation and disease. Deer also become accustomed to humans and lose their fear of being around human communities. A feeding area attacks larger groups of deer that may result in more damage as well as encouraging

them to travel, increasing their chance of being hit by a vehicle. Using fencing and repellents may also help people reduce the presence of deer in undesired areas.

Urban White-tailed Deer
© Mack Male

Coyotes – Coyotes are a very common wildlife species seen throughout North America, including in Manitoba. They are well adapted to live in urban centers. They are also suitable hosts for canine distemper, rabies, canine hepatitis, the parvovirus, mange, tapeworms (*Echinococcus multilocularis*, and *Taenia* spp.), nematodes, and heartworm (*Dirofilaria immitis*). All of these pathogens can be transmitted to domestic dogs, other pets, sometimes humans and wildlife species. Coyotes can also cause damage to property, including hunting domestic livestock. They will also go through garbage and fight with pets. On rare occasions, they have been known to attack humans, especially after being fed by people in the past.

Managers try to make sure people do not feed coyotes, especially near human homes. They also try to keep garbage in proper containers. They suggest people closely supervise their children while outside and keep pets in at night. They also recommend avoiding contact with feces (of coyotes and any wild animal) and making sure your pet does as well. Coyotes are trapped using humane traps and trapping techniques annually in Manitoba.

Raccoons – Raccoons are one of the most commonly problematic wildlife species in urban areas in Manitoba. They are an extremely adaptable species that is able to live almost anywhere. To manage raccoons in the city, managers ask people to supervise their children and inspect outdoor play structures as well as covering sand play boxes as they may be used by raccoons as latrines. They ask people to not deliberately feed raccoons, or leave garbage or pet food outdoors. Protecting outdoor fishponds with metal screens or mesh is important. Block any access (no matter how

Urban raccoons
© Andy Langager

small) to attics, sheds, chimneys, or other potential dens and replace old wooden roof materials. If you encounter a raccoon, make sure not to fed, disturb or handle it. Do not adopt young as pets. If you have to clean up raccoon faeces, you should use shovels, disposable rubber gloves, strong disinfectants, and masks to collect the faeces, which should then be buried or sent directly to a landfill. Raccoons serve as host to many pathogens, including rabies and canine distemper as well as many other dangerous parasites that may be transmitted to other wildlife, pets, or humans.

PATHOGEN AND DISEASE MANAGEMENT

Wildlife pathogens and disease represent significant management concerns in North America. Interactions between wildlife and livestock as well as wildlife and human populations (with their pets) represent an important management concern, particularly when examining the potential for pathogen transmission.

Pathogens are a natural part of any ecosystem. Species within the environment have evolved alongside parasites and pathogens. Parasites induce specific reactions and changes in the immunity, physiology, and host behaviour. The hosts, or wildlife, use these changes to counteract the parasite attack. The actions of parasites on populations help select for individuals with increased resistance to this parasites invasion. Parasites also keep evolving alongside their hosts.

The need to manage pathogens and disease in wild animals is a relatively recent phenomenon. Previously, management only occurred when major events happened, often involving the health of domestic animals or humans. Recent interest in managing pathogens and disease in wild animals has been caused by several factors. Wildlife can serve host to pathogens that are zoonotic, such as Lyme disease, haemorrhagic fevers, and the hantavirus. Wildlife can also serve as a reservoir for pathogens that cause disease in both wildlife and domestic animals. For example, bovine tuberculosis and brucellosis are two pathogens causing disease in wildlife that are transferred to domestic animals. As long as the wildlife remains a reservoir for these pathogens, we cannot eliminate them from domestic animals. Humans have increased their domestication of native species, such as elk and deer, for game farming. This increases the rate of pathogen transmission to and from free-ranging individuals. There also has been the increased awareness of the risks with the movement of wild species with their pathogens. The general concern about the well-being of wild

populations, particularly in light of habitat degradation, fragmentation and loss, as well as climate change has also raised the concern.

Three management strategies exist for managing wildlife pathogens and disease:

1. Prevention of introduction of pathogen – measures designed to exclude or prevent the introduction of a pathogen into unaffected individuals or populations. *Includes* habitat modification, changes in human activities, restricting translocation of wildlife

2. Control of existing pathogens and diseases – reduce frequency of occurrence or the effects of a pathogen within an individual animal or population to an acceptable or tolerable level, or to contain the spread of the pathogen. *Includes* immunization of hosts

3. Eradication – total elimination of an existing pathogen. *Includes* using disinfection or treatment of the hosts or habitat, selective culling of hosts (reducing density),

These management techniques may be directed at the pathogens, the host population, habitat, or human activities. Proper management requires knowledge of the ecology of the pathogen, its life history, the course of the disease it causes, and the population biology of the parasite-host interaction.

ENDANGERED SPECIES

Various factors, including human activities and climatic changes, have led to the reduction and alteration in animal populations. In response, government wildlife agencies and public groups have formed the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) which encourages and commissions studies on rare and endangered animals or animals of unknown status. Some of the most endangered species in North America are seen below: Vancouver Marmot, Red wolf, Pygmy Raccoon, Staghorn coral, Oahu tree snails, Giant seabass, Kemp's Ridley Sea Turtle, California Condor, and Franklin's Bumblebee

Other groups, such as the International Union for Conservation of Nature (IUCN) have taken this idea internationally, trying to monitor and report on wildlife populations worldwide. The IUCN Red List of Threatened Species is a world-renowned database of information collected over the last four decades. The IUCN Red List assesses both plants and animals and provides taxonomic, conservation status, and distribution information. The IUCN Red List sorts each species into one of the following categories:

Extinct – a species or taxon is extinct when there is no reasonable doubt that the last individual of this group has died. Exhaustive surveys of known and expected habitat during appropriate times will have failed to record the presence of this species.

Extinct in the Wild – a species is considered to be extinct in the wild when they are only known to survive in cultivation (e.g. farming), in captivity (e.g. zoo), or as a naturalized population well outside their past range. As with extinct animals, exhaustive surveys of known and expected historical habitat during appropriate times will have failed to record the presence of this species.

Critically Endangered – a species is considered to be critically endangered when all evidence indicates that its population has either: (a) been seen to be reduced by 90% or more in last 10 years or three generations, (b) its geographic range has been reduced to less than 100 km^2 and severely fragmented or less than 10 km^2, (c) population less than 250 mature individuals and continuing to decline, (d) population size of less than 50 individuals, or (e) quantitative modeling suggests the probability of extinction at least 50% in the next 10 years. It is considered to be facing an extremely high risk of extinction in the wild.

Endangered – a species is endangered when the evidence indicates that its population has either: (a) been seen to be reduced by 70% or more in last 10 years or three generations, (b) its geographic range has been reduced to less than 5000 km2 and severely fragmented or less than 500 km2, (c) population less than 2500 mature individuals and continuing to

decline, (d) population size of less than 250 individuals, or (e) quantitative modeling suggests the probability of extinction at least 20% in the next 10 years. It is considered to be facing a very high risk of extinction in the wild.

Vulnerable – a species is considered vulnerable when its population meets any of the following criteria: (a) been seen to be reduced by 50% or more in last 10 years or three generations, (b) its geographic range has been reduced to less than 20 000 km^2 and severely fragmented or less than 2000 km^2, (c) population less than 10 000 mature individuals and continuing to decline, (d) population size of less than 1000 individuals, or (e) quantitative modeling suggests the probability of extinction at least 10% in the next 10 years. It is considered to be facing a high risk of extinction in the wild.

Near Threatened – a species that is near threatened is close to meeting the criteria for critically endangered, endangered or vulnerable in the near future.

Least Concern – a species is least concern when it does not meet any criteria to qualify for critically endangered, endangered, vulnerable, or near threatened. Species that are widespread or abundant are included in this category.

INVASIVE SPECIES

Invasive species are organisms, including plants, mammals, birds and crocodiles, amphibians, invertebrates, reptiles (lizards, snakes, turtles), and microorganisms that spread beyond their natural range into new locations. This expansion is often due to human activities. Invasive species are more commonplace than one might think. Kentucky bluegrass, periwinkle, lily of the valley, and dandelion are all common plant species found in our lawns and gardens but are invasive species to this region. The domestic cat is thought to have originated in Africa. The European starling came from Europe. Some species have moved within the country into areas they have been previously absent. For example, the moose is an introduced species on Newfoundland but is native to most of Canada. The house finch, native to several western provinces, is now found in a number of eastern provinces.

Alien or invasive species can be beneficial in a region but a good number are not. Sometimes the invasive species does not have the same limiting factors in their new habitat. This can lead to populations growing beyond control.

Invasive species come into Canada by any means of transport that moves them farther than they could move on their own. Sometimes they are brought in on purpose, but often they arrive unintentionally. Seafaring European explorers and settlers were the first to introduce new species to Canada. They brought cattle, goats, and other domestic animals, along with familiar crops like wheat, when they came by ship to explore and settle the New World. Without meaning to, they also introduced unwanted organisms—pests, like the Norway rat, and viruses, like deadly influenza and smallpox.

Many invasive species are transported to an area by accident. Accidental arrivals are rarely discovered until they have established themselves and have spread beyond their point of entry. For example, many unwanted invasive species arrive in ballast water, the seawater or freshwater used to stabilize large ships during travel; aquatic species are taken up along with ballast water at one port and released at the destination port. About half of the invasive shellfish species in Canada, including the highly invasive zebra mussel, as well as the invasive zooplankton, the spiny water flea, probably arrived in North America in this way.

When an invasive species enters an ecosystem, it can have an impact on the species that are present, on important habitats, or even on the ecosystem itself. Concern arises when an invasive species changes the system for the worse, by either reducing or eliminating populations of native species, or by otherwise changing the way the ecosystem works. These changes have made the invasion of alien species a major global problem. If organisms were not able to move beyond their normal ranges, each part of the world would have a unique array of plants, animals, and microorganisms. However, as species move from one area of the world to another, sometimes squeezing out the competition, different places in the world become more alike in their biology—a process called biological homogenization.

Biological homogenization is undesirable because as it takes place, ecosystems often become less stable, and valuable biodiversity, or variety of life, is lost. This variety is essential to the health of our planet; each species performs a function that contributes to global well being. The spread of invasive species, like habitat loss, is considered one of the major threats to biological diversity. Invasive species have obliterated over 110 vertebrate species around the world and have affected nearly every type of ecosystem. For example, in New Zealand, predatory European mammals such as rats, cats, and stoats have caused the extinction of nine native bird species, and they threaten many more. In Guam, the brown tree snake, an import that arrived hidden in ship cargo from New Guinea, has wiped out virtually all the island's native forest birds.

Invasive species are successful due to some advantage they have over native species. For example:

Competition: invasive species can often outcompete native species for space, water, food, and other essential resources

Predation: some invasive species cause native species to decline by being aggressive herbivores or predators.

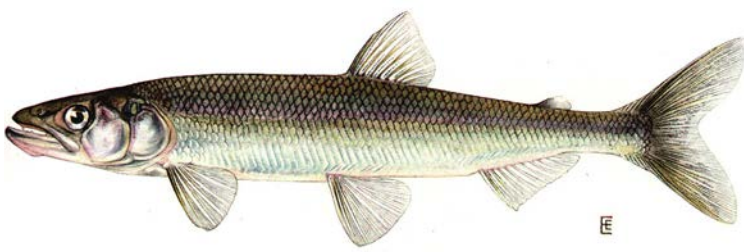
Pathogens and parasites: often invasive species bring with them novel parasites or pathogens to a region. Sometimes the invasive species is a parasite itself and can affect population dynamics

Hybridization: sometimes invasive species weaken the gene pool of the native species by interbreeding with them, a process called hybridization.

Habitat alteration: invasive species may change the structure or composition of a habitat; invasive species make it unsuitable for other native species.

There are quite a few examples of invasive species in Manitoba that are of great management concern. They include the leafy spurge, Eurasian watermilfoil, yellow flag iris, flowering rush, purple loosestrife, narrow-leaved and hybrid cattail, common carp, rainbow smelt, round goby, rusty crayfish, spiny water flea, zebra mussels, yellow starthistle, tall buttercup, lily leaf beetle, and dutch elm disease fungi.

Rainbow smelt (*Osmerus mordax*) are an elongate fish between 178-203 mm long. They are found in clear lakes, rivers, and coastal waters including Lake Winnipeg. Rainbow smelt compete with native fish species for food and other resources. They are also a source of food for other species of native fish. Affected native species include yellow perch, cisco, emerald shiner, walleye, lake erring, bloater, whitefish, lake trout, and slimy sculpin.



Rainbow smelt
© Ellen Edmonson and Hugh Chrisp

The rusty crayfish (*Orconectes rusticus*) is an aggressive species that originates in the Ohio River basin (USA), which began to spread into the northern Great Lakes regions, including Minnesota, Wisconsin, and Ontario in the 1960's. They are often spread when they are used as bait by anglers. Rusty crayfish reduce aquatic plant beds and the species that live in these environments. It has been suggested that the damage that the rusty crayfish does to the aquatic ecosystem is the equivalent to clear cutting forests. They feed heavily on aquatic plants, small fish, and water insects. Rusty crayfish are relatively new to Manitoba, being first spotted in 2007. Managers have been using information campaigns with recreational

anglers to try to reduce the spread of this invasive species.

Emerald Ash Borer (*Agrilus planipennis*) are invasive insects originally from eastern Asia. This species consumes and destroys ash trees. It likely came to Canada from a shipment of untreated wooden packing material from Asia. Adult emerald ash borer feed on the leaves of the ash trees producing irregular shape patches with jagged edges. Eggs are then deposited in the truck and branches of trees within the bark. When the eggs hatch, the larvae burrow in the bark into the cambial layer. As the larvae feed, they create s-shaped tunnels and eventually girdle (complete removal of a strip of bark from around the entire circumference of either a branch or trunk of a woody plant) the tree.

Invasive rusty crayfish
© Doug Watkinson, DFO

Invasive Emerald Ash Borer
© David Cappaert/Michigan State University

Various management techniques can be used to both slow and prevent the spread of invasive species. Cooperation between different countries and their experts is key to developing programs like the Global Invasive Species Program. Canada has instituted many laws, regulations, and policies, aiming to prevent the spread of invasive species. Further education initiatives, such as with zebra mussels and spiny water flea campaigns with anglers, will further assist in preventing these invasive species to spread further. Targeted control, including physical control (i.e. physically removing the species from its environment), chemical control (i.e. pesticides, herbicides, fungicides, and other chemicals to kill invasive species), biological control (i.e. using living organisms, particularly predators, parasites, and disease are used to control the growth of invasive species populations), and integrated control (i.e. combination of all listed above).

CLIMATE CHANGE

Climate change, or the alteration and lasting change of the distribution of weather patterns over period of time, is something that the earth is now facing. Of all the ways in which human activity affects the distribution and abundance of wildlife on our planet, none is as pervasive and powerful as climate change. All species have a capability to adapt – at least to some degree – to natural stresses. Changes to climate and habitat have been occurring for eons, and with them have come changes to the diversity of species on earth. What makes current climate change unique is that, with the exception of cataclysmic events such as meteor strikes, the rate at which it is taking place is leaving species and ecosystems no time to adapt.

The direct impacts of human caused climate change have now been documented on every continent, in every ocean, and in most major taxonomic groups. One of the most studied and observed climate change responses of organisms has involved alterations of the species' phenologies (the study of periodic plant and animal life cycle events). For example, humans have been recording the flowering of cherry trees in Japan since the 1400's. Although the timing of the flowering is highly variable among years, no clear trends have been observed between 1400-1900. Since the early 1900s to 1952 the date of flowering has steadily moved earlier into the year. In the past few years, the flowering time has moved even earlier. Another study examined the calling of six frog species in Ithaca, New York. These frogs use calling as part of their mating ritual. The study found 10-13 day advancement in this calling. Further, amphibian breeding has also started 1-3 years earlier per decade of change.

The problem with these shifts in life history comes when they start to become mismatched with other events in the environment. For example, many species of songbirds rely on huge increases in insect populations (seen after the insect's successful breeding) to feed their young. Activity and reproductive cues for many species of insects are related to the ambient temperature. If the temperature continues to increase, insects may start to become active sooner and breed earlier. If the breeding time of songbirds does not change in sync with the insects (due to other drivers in their life cycle such as daylight hours) they will miss this large population boom of insects, not be able to feed their young, and their populations will suffer.

The increase in storms and unpredictable weather patterns is also expected with climate change. These extreme weather events can devastate wildlife populations as well as their habitat. This puts already vulnerable species further at risk of extinction.

Another direct impact of climate change is the loss of habitat. The decline in sea-ice extent has led to large changes and in turn trophic cascades in both the Antarctic and the Arctic ecosystems. In the Antarctic, declines in sea ice have reduced the abundance of ice algae (due to loss of habitat), leading to declines in krill (38-75% per decade since 1976). Krill is the primary food source for many species of fish, seabirds, and marine mammals. Emperor penguins have declined from 300 to 9 breeding pairs in certain portions of their range and other areas have shown a reduction by 50% of their population since 1970. Adelies penguins have seen similar declines. In contrast, open-ocean feeding penguins, such as the chinstrap and Gentoo, have increased their range. In the Arctic, invertebrate communities in Arctic lakes have shown hug species turnover (change in the community of organisms). Polar bears have suffered significant population declines. Climate change has caused a lengthening of the ice-free period, periods during which the polar bears live only on their fat reserves, as an ice shelf is essential for feeding. Further, climatic warming trends have led to a reduction in their main food source, the ringed seal.

The movement of parasites and pest species is another component of climate change. A nematode parasite has seen an increased abundance due to a shortening of its life cycle in response to warming trends. The increased abundance has had associated negative to its wild musk oxen host, decreasing their survival and ability to breed.

Increasing temperatures can also lead to both local and worldwide extinction of wildlife species. Global sea surface temperatures have risen an average of 0.1-0.2°C since 1976. El Nino events (climate pattern that increases the temperature) alongside global climate warming has led to 16% of all corals rendered extinct globally.

WILDLIFE RESEARCH METHODS

FIELD NOTES

A wildlife biologist or naturalist should always keep field notes and a journal as an essential record of activities and observations. Keeping accurate field notes and a good journal enables one or others to return to the same areas in the future and look for important ecological changes. A journal also provides a good record of one's investigations, observations, thoughts, speculations, and random musings of the field. Although certain details may not seem useful or applicable at the time, great discoveries and revelations have been made by referencing back to ones field notes.

Good field notes include quite a few things:

1. Name of observer(s)
2. Date, time, and locality of the day's observations
3. Numbered pages
4. Weather should be noted at the beginning of the day and whenever significant changes occur
5. Recent events (fires, storms, or droughts, for example)
6. Brief description of the habitat including the topography (flood plain, forest, sedge meadow, fen, etc.) and vegetation (oak-pine forest, wetland, etc.)
7. GPS location of any observation
8. Route traveled
9. Quantitative (numerical) data (for example estimates of the numbers or sizes of individual plants and animals seen, frequency of events, etc.) and other observations (e.g. other animals or plants)
10. Records of collected items (e.g. samples taken such as plant samples or fecal samples)
11. Photos taken and their location
12. Thoughts, questions, speculations, etc.

An example of a page out of a field journal:

Page 1

Name: J. Doe
Date: 22 04 2013
Time: 19:30

Location: Den E25, Wapusk National Park (near Nestor One)
Habitat: Tundra, beach ridge, fox den
Temperature: -21°C **Humidity:** 60%
GPS Coordinates: 15 473110 6473943 UTM

Data and Observations:

- Fox burrow present with fresh digging, two entrances
- Fox feces present
- Urine present
- White hair (Arctic fox) present in fox burrow
- No fox tracks present
- Ptarmigan present at den with lots of ptarmigan feces
- Large tracks (likely polar bear) present at outer edge of den
- Deep snow but some vegetation still obvious

Photos:
IMG_0986 – burrow opening
IMG_0987 – researching examining burrow opening
IMG_0988 – Ptarmigan

Collected Items:

- Fox feces collected and labeled
- White hair from burrow opening

Field journals can be more detailed depending on the project. In many behavioural observation studies or mark-recapture studies, the researcher often records the mass of the animal, sex, tag number, pit tag, spine length, etc. The more detailed the field notes the easier it is to come back to them as a reference.

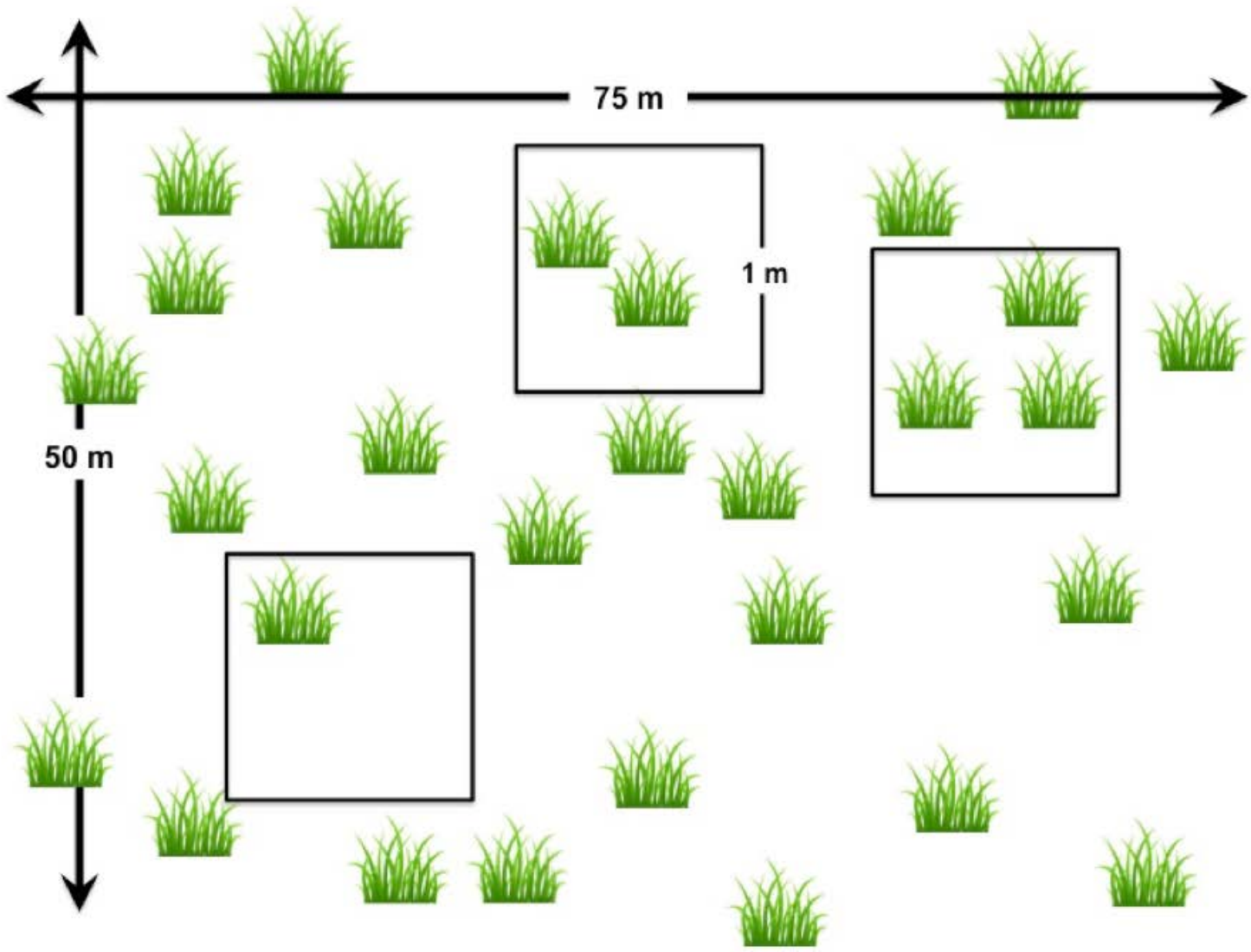
POPULATION MONITORING

Ecology is defined as the study of the factors that affect the distribution and abundance of organisms. Therefore, as ecologists, wildlife biologists, and managers, determining the

abundance of a specific group of organisms are important. To estimate the population size a researcher can use various methods.

Complete census: this method will count all the organisms. Often this method is difficult to do, difficult to tell if you have found all of the individuals in an area, takes a large amount of time. Further, how important is it to count every individual? For this reason we use samples from a population to estimate abundance under the assumption that it is representative of the entire population.

Quadrat Sampling: in this method you define a quadrant (small area of known size) that is chosen at random and count the number of organisms in that region. The mean (average) number of organisms in each quadrant is used to estimate the entire population. This method is used when the organisms are sedentary, e.g. plants or trees.



Mean plant density (number/m^2) x total area = population size

2 plants/m^2 x (50m x 75m) = 7500 plants

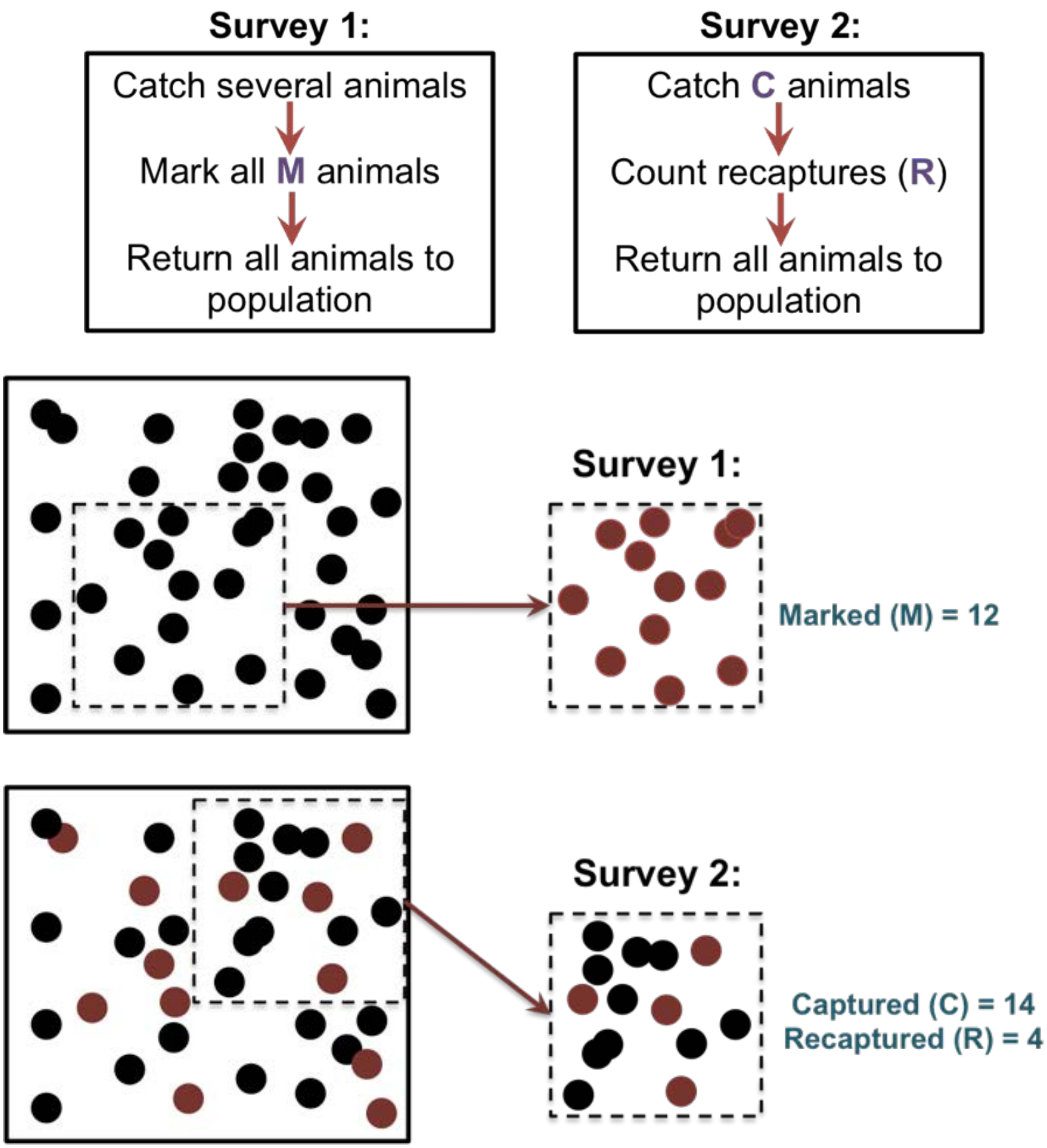
Many plants or animals do not distribute themselves evenly across the landscape. Due to this habitat heterogeneity (patchiness) we need to choose a sampling strategy that best

captures the population and minimizes our variability of measurement. The edge effect is also something to consider when designing a sampling method. Individuals on the edge may or may not be counted, but this needs to be consistent to reduce counting errors. The plot size is also a factor to consider. The larger the quadrant area the less variability present. However, larger quadrants take more time to evaluate.

Transects: transects can be used in various forms to evaluate populations. A transect is a path along which one counts and records the occurrence of an individual or an object that is being counted as a representation of the occurrence of an individual or species. For example, many species of lemmings (brown and collared) as well as voles make winter nests in their tundra habitats. These winter nests are made from vegetation (mainly grasses and sedges) underneath the snow (subnivean layer) and are used to keep the small mammals warm during the winter. They appear like a ball of cut grass and are abandoned in the spring. They are counted and picked up as a representation of the winter small mammal population. To evaluate the small mammal population, researchers walk transects of a known distance and count each winter nest they encounter. If the winter nest is not on the straight line transect, the researcher leaves the transect at a 90° angle and measures the distance between the transect and the winter nest. Transects have also been used to evaluate snowshoe hare populations by looking at pellets at specific locations down the transect.

Mark-recapture: mark-recapture methods are one of the most common and best methods to get information not only on abundance, but birth, death, and movements. It can require substantial time and effort to collect this data. They are commonly used to monitor small mammal populations, but are not limited to this function. They have also been used (for example) to look at the growth and condition of American alligators, dynamics of increasing lake trout populations, and different responses of Agriotes click beetle species to pheromone traps. The methods for mark-recapture vary between populations that are closed (stable, no birth, deaths, or movements) or open (major changes in size and/or composition during the study). There are four methods for closed populations, Petersen method, Schnabel method, and Schumacher-Eschmeyer, and one common method for open populations, Jolly Seber. We will focus on the Petersen method, one of the most simple methods for a closed population.

Petersen Method (Closed population)



Total (estimated) population size (N) calculation:

$$\frac{\textit{Number marked individuals (M)}}{\textit{Estimated population size (N)}} = \frac{\textit{Number recaptured individuals (R)}}{\textit{Number of individuals captured in resampling (C)}}$$

$$N = \frac{MC}{R} = \frac{12 \; x \; 14}{4} = 42$$

If you have a small number of individuals caught in the surveys, you can make a correction to account of these small sample sizes. For our example above…

Total (estimated) population size (N_c) corrected:

$$N_c = \frac{(M+1)\,x\,(C+1)}{R+1} - 1$$

$$N_c = \frac{(12+1)\,x\,(14+1)}{(4+1)} - 1 = \frac{13\,x\,15}{5} - 1$$

$$N_c = 38$$

Mist Net: Mist nets are an important tool for monitoring the population of both birds and bats. It also helps assess the species composition of a region, the relative abundance of different species, the overall population size, and the survival of individuals. Mist nets are large nylon nets that are suspended between two poles that appear almost invisible when used properly. The grid size of the mesh on these nets will vary according to the size of the species researchers desire to catch. Nets are often set up at dawn and dusk as many species of birds are the most active during these times. Nets are then monitored until birds are caught. Once a bird is entangled in the mist net it must be extracted (as seen in the photo to the right). This removal takes experience and proper training to do without injuring the bird. Once the bird is removed, a researcher may band the bird (for identification of the bird later on and mark-recapture studies) as well as record the species, sex, age, size (length and mass), and body and reproductive condition.

Mist Net with songbird
© J. Surgey

Bal-chatri: Bal-chatri traps are used to catch raptors. It consists of a cage with a visible rodent and a series of monofilament nooses attached to the surface that functions to snag the legs of free-flying raptor when

Bal-chatri trap with rodents
© T.J. Poczciwinski

they attempt to catch the prey. Researchers will travel in an area in which they are interested in monitoring raptors. Once a raptor is observed, the trap is thrown out of a vehicle on the opposite side from the raptor's location (to ensure the raptor does not observe the deployment of the trap). The raptor will attempt to capture the small rodent and in doing so will be caught in the monofilament nooses. The rodents very rarely harmed. Once caught, researchers will come remove the bird, often tag the bird and make record of its species, sex, age, size (length and mass), and body and reproductive condition.

Breeding Bird Atlas: The Manitoba Breeding Bird Atlas is a five-year project examining the distribution and abundance of all the breeding birds in Manitoba. The province has been split up into 14 administrative regions in which they ask volunteers to go and observe birds and bird nests. The research is carried out during the main bird breeding season between late May to mid-August. A volunteer will venture into a specific area that is 10km^2 in size. They will visit this area more than once in the breeding season. Each time the volunteer will take record of any birds the observe and if there may be breeding in the region (suitable habitat, singing associated with breeding been observed in adults, pairs of birds, courtship displays, bird visiting a regular location, brood patch on a caught bird, agitated behaviour of a bird, nest building, distraction displays (such as the broken wing display), fledged young, nests with eggs or young). They are also asked to take point counts (abundance estimates of birds in one place – both by visual and audible evidence). Example forms for both types of counts are attached in the appendix.

DIET RECONSTRUCTION

Knowledge about the diet of wildlife not only helps us have a better understanding of the ecology of a region, but also the relationships between species, the role of a species in the ecosystem, potential for competition with other species, their impacts on prey populations, and factors that limit their abundance and impact dynamics in the ecosystem.

Many methods are used to estimate diet of animals:

Observational: by observing feeding behaviour (e.g. following a wolf pack to their kill, watching a fox or owl hunt, etc.) we get some insight into both the food items included in an animal's diet but also their hunting or scavenging behaviours.

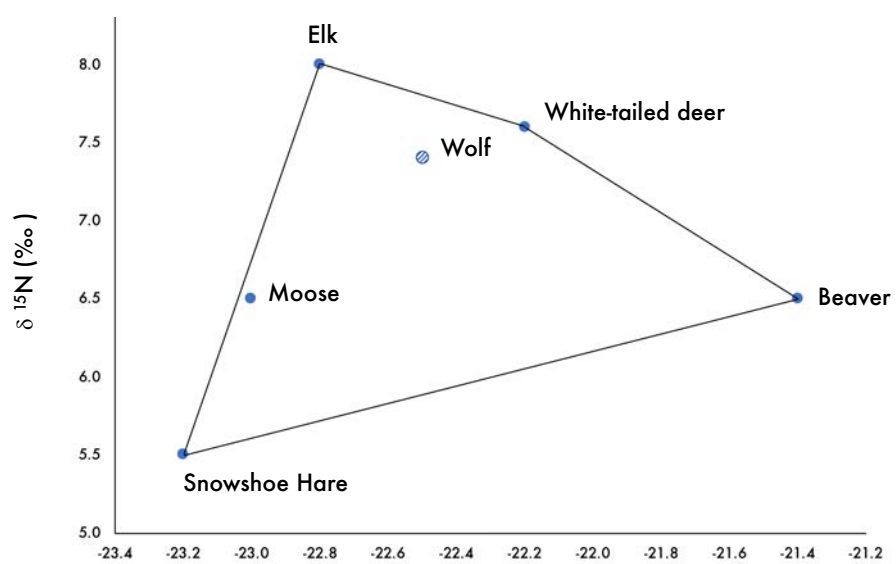
Stomach and fecal analysis: Stomachs and/or feces are collected to look at the diet of each individual. It gives insight into the animal's last meal. Remains from the food items, such as

bone, hair, eggshells, feathers, seeds, and exoskeletons (e.g. insects and zooplankton) survive the digestive process and can be used to identify the prey. They can also be quantified to provide estimates and importance of each item. Owl pellets can also be used in a similar manner to reconstruct their diet. Although this method can be good in giving a broad idea of the foods included in a population's diet, most soft-bodied prey are difficult to identify since they digest rapidly.

Fatty acid signature analysis: Fatty acids can be used as a natural biomarker to assist in the reconstruction of a predator's diet, particularly when the diet is of marine origins. Fatty acids are the main part of most lipids (or fats) and unlike many other nutrients (e.g. proteins and carbohydrates) are not readily broken down during digestion. Animals can also only make a limited number of fatty acids; we are able to distinguish between fatty acids created by the body versus those taken in from the diet. The fatty acids are passed on from prey to predator throughout the food web. Fatty acids can also represent the diet of the predator over a longer period, representing the average diet of an individual over a set time (e.g. a month, year, etc.).

Stable isotope analysis: stable isotopes are a natural biomarker (like fatty acids) that can be used to reconstruct diet of an animal. Researchers measure the ratio of heavy to light isotopes of different elements (e.g. carbon, nitrogen, sulphur, oxygen, hydrogen, etc.) which have been transferred from the food item (plant or animal) to the consumer. Stable isotopes can indicate the trophic level the animal is eating at, the length of the food web, and source of primary production in this food web. They also can be used to study animal movement, looking at where an animal may spend its winter or migrate.

Carbon and nitrogen are the two most commonly used stable isotopes ratios in reconstructing the diet as carbon is influenced by the type of plant eaten by the primary consumer and nitrogen increases with every increase in trophic level. Marine and terrestrial stable isotopes also vary greatly in carbon stable isotope ratios. Due to these differences, researchers are able to start to reconstruct the diet of an individual consumer. Further, using the stable isotope ratios of the consumer you can look at the overlap of the diet of two competing species.



Stable Isotope Food Web
(Urton and Hobson 2005)

A researcher can also use different tissues from the consumer that represent the diet of the individual from different periods. For example, the blood of an animal is rapidly turned over and so its stable isotope ratios will represent the diet of the animal over the past few days. On the other hand, muscle represents the diet of the individual over the past few months.

To reconstruct the diet of an individual, or a population, a researcher (with modelling software) will examine the stable isotope values of the consumer (e.g. wolves in the example below) and compare its 'location' (represented by its carbon and nitrogen stable isotope values) to those of possible prey (e.g. white-tailed deer, elk, beaver, snowshoe hares, and moose in the example below). Based on its distance from these possible prey, the proportion of each type of prey in the diet of the consumer (e.g. wolf) can be estimated.

BASIC AND APPLIED ETHOLOGY

Ethology is the systematic study of the behaviour of animals in the wild. Animal behaviour is the expression of an effort to adapt or adjust to different internal and external conditions, simply, an animal's response to a stimulus. The study of behaviour includes not only what an animal does but when, how, why, and where the behaviour has occurred. The study of animal behaviour concentrates on four main questions:

1. **How is the behaviour accomplished?** e.g. cockroaches running away from toads use wind-sensitive hairs on their bodies to predict the point at which the toad has committed itself to strike in a certain direction. The cockroach will then turn and run away once the strike has started.

2. **How does the behaviour contribute to the animal's survival and reproductive success?** e.g. cockroaches running only when they are certain of an actual threat so that they do not waste resources on unnecessary effort

3. **How does the behaviour develop during the animal's lifetime?** e.g. does the animal have to learn the behaviour or does it behave this way without prior experience?

4. **How did the behaviour evolve is asking how did certain behaviour develop?** e.g. beak-wiping in the zebra finch which is also exists in the embryonic form of a closely related finch species.

Animal behaviour is often observed and recorded as part of an experiment. To do this, a research needs to choose the relevant observations for their project, define the behaviour to

be observed (described on an empirical basis (not an interpretation of behaviour – e.g. yawning but not bored, happy, restless, etc.) or an ethogram (a catalogue of the behaviours of a species), have an observation schedule, and consider other variables (e.g. spacing arrangements between animals, orientation, posture, various behavioural rhythms (over times and seasons), and age and sex of animal). A researcher writes observations down in a notebook, uses videotape recordings, or uses single-event recorders (e.g. critter-cams). Once the behaviour is observed and recorded, it can be quantified so that these behaviours can be analyzed. The frequency or magnitude of the behaviours can be recorded (e.g. how often does the arctic fox stretch?). The duration of behaviour can be recorded (e.g. how long does a coyote drink?). If social interactions are being examined, recording which individuals participated in the behaviour, which individual started the behaviour, and which individual ended the behaviour are all important (e.g. social grooming in some species of primates).

Research in animal behaviour is wide ranging and can involve many different approaches.

Observational (field): animal behaviour is observed in a natural environment without interference and trends are observed. For example, polar bears in the Hudson Bay region are recorded (by both photos and video-taped) and analysed interactions between individuals, movements, play behaviour as well as identifying each individual (for more information visit http://www.polarbearlibrary.org/).

Manipulative (field): animal behaviour can be observed in a natural environment with some manipulation by the researcher. For example, mobbing behaviour (or predator harassment) has been studied in different species by exposing the animal of interest (e.g. ground squirrel) to the scent, model, or caged predator or threat (e.g. snake). Ground squirrels often will mob a predator to identify this individual in the environment and reduce their chances of being killed by this predator (e.g. snakes, lizards, etc.) as well as the chances of this predator eating other members of their group (possibly including their young). To study this behaviour, a researcher may introduce a predator (such as a snake) into an area with a group of ground squirrels and observe the resulting behaviour. They may consider which members of the group participated in this predator harassment, including if they were male or female, juveniles or adults, and if they had young. The researcher also may place the scent in the group to try to figure out if it is the sight or scent or a combination of these both that cause the squirrels to mob.

Another example may include understanding the communication between members of a social group. For example, the Richardson's ground squirrels have alarm calls to warn other members of the group of any incoming threat, such as a predator. Researchers have been interested in the information conveyed between individuals with these alarm calls.

Researchers have recorded the alarm calls of Richardson's ground squirrels by using an avian predator model. They then played these calls back to individuals in the field to detect if individual squirrels paid more attention to calls made from neighbours than from non-neighbours.

Manipulative (lab): Wild animals are often studied at zoos. As a concentration of wildlife kept in human made conditions, they provide the opportunity to study species that are difficult to access or study in the wild. Studies may include group interactions, as well as reactions to stressful events (e.g. proximity to predators), as well as communication between individuals.

ANIMAL TRACKING IN MANITOBA

To try and understand population sizes, migratory routes, or other information about animal populations, researchers will often track the animals using a variety of different animals. With larger animals such as caribou and polar bears, the animal is usually tranquilized then fitted with a radio collar (picture below), which allows for the individual to be tracked from a plane.

Smaller animals, like birds or bats, can't wear conventional radio collars because they are too small. In this case, bands or PIT (Passive Information Transponder) tags are used for monitoring. In Manitoba, birds are banded to track their migration routes and to gather information about population sizes. Birds (and bats) are often caught using a mist net. Once removed from the net, a small band is placed on one leg that is unique to each individual. Migration routes can be mapped when a banded bird is caught in another location.

In Manitoba, bats were formerly tracked with bands just like birds, but the bands were placed on the arm at the top of one wing. However, banding bats was found to cause occasional wing damage or injury to the bat. Now, bats are monitored using PIT tags that are inserted under the skin between the shoulder blades. PIT tags (see picture below) cannot be monitored from a plane, but by panels placed at the entrances to caves or mines that read the "barcode" of each bat as they fly by, or by PIT tag readers used to scan bats that are captured. To insert the PIT tag, bats are captured using mist nets or harp traps. Currently, researchers at the University of Winnipeg are monitoring bat populations because of the disease White-Nose Syndrome (WNS) caused by an invasive fungus, which hasn't arrived in Manitoba but is now as close as North-Western Ontario. Each bat that is PIT tagged also has a genetic sample taken from it. Researchers hope to be able to look in the genes of bats that survive WNS to find a cure for the disease.

MAMMALS OF MANITOBA

Manitoba has a great diversity of mammals, reflecting the wide diversity of ecosystems within this large province. Manitoba contains prairie, parkland, boreal forest, and tundra. Over 89 mammal species live within these terrestrial and aquatic ecosystems and the coastal waters of the Hudson Bay.

The section is by no means an exhaustive list of all the species within the province, as many of the small mammals (e.g. rodents, bats, shrews, and moles) are not included. Each entry aims to give a brief description of the appearance and size of the organism, some life history characteristics, as well as any unique features of the specific species. There is also a short section describing some of the important ecosystem roles of each species, any management issues it may be facing, and its current population status. Tracks are included for a few species as they may be a way of identifying the species presence in the wild.

ORDER SORICOMORPHA (SOLENODON, SHREWS, AND MOLES)

Star-nosed mole (*Condylura cristata*)

Star-nosed moles are one of the most distinct mammalian species. They have hairless noses that are ringed by a unique 'star' made of 22 pink, flesh tentacles. The 'star' is bilaterally symmetrical, with 11 appendages per side, measuring between 1-4 mm long. They are stout, with roughly cylindrical bodies. As they are fossorial (adapted for digging and life underground) mammals, they have heavily-built forelimbs, with broad feet and large claws. Their hair is short, dense, and course.

Star-nosed mole (*Condylura cristata*)

Size – Adults weigh between 35-75 g and range in length between 0.175-0.204 m.

Lifespan – 3-4 years (estimate)

Diet –Primarily on invertebrates, such as earthworms, and aquatic species such as leeches, and aquatic insects (e.g. larvae of caddisflies, midges, dragonflies, and damselflies, etc.). Occasionally aquatic crustaceans and small fish.

Denning and Habitat – Star-nosed moles are found in varied habitat, all characterized by moist soil. They prefer areas of poor drainage, including coniferous and deciduous forests, clearings, wet meadows, marshes, peatlands, and banks of streams, lakes and ponds.

Predators –Owls, hawks, domestic dogs and cats, fox, skunks, weasels, fishers, minks, bullfrogs, and largemouth bass

Special features – Star-nosed moles are a fossorial mammal, digging a network of tunnels throughout moist soil. The tunnels can extend as much as 270 m along the edge of suitable habitat. Star-nosed moles are semi-aquatic, so many of their tunnels open under the surface of a stream or lake. They are well adapted for swimming, with forelimbs used as paddles. They are commonly active throughout the winter, burrowing through the snow and even swimming under the ice of frozen ponds. The tentacles on the nose assist the star-nosed mole in finding prey. Typically, if the moles are foraging, the tentacles are constantly being

used to feel around the surroundings, moving so quickly they appear as a blur (touching as many as 12 objects per second). The tentacles are so supersensitive, they can identify prey in under half a second.

ORDER CHIROPTERA (BATS)

Brown Bat (*Eptesicus fuscus*)

Brown bats (also known as the big brown bat) are medium sized bats with large skulls, broad noses and fleshy lips. Their ears are rounded and the tragus (prominence on the inner side of the external ear, important in echolocation) is broad with rounded tip. Their fur coloration depends on the location and subspecies, with the dorsal side raging from pink tans to chocolates and the ventral fur lighter from pink to olive. The face, ears, wings, and tail membrane are all black.

Brown Bat (*Eptesicus fucus*)
© Cory Olson

Size – Adults weigh 23 g (average) and ranges in length between 0.11-0.13 m long. Its wingspan is around 0.33 m long.

Lifespan – Up to 19 years (males longer lived than females)

Diet – Insects, primarily beetles, but also moths, flies, wasps, flying ants, and dragonflies.

Denning and Habitat – Located in cities, towns, and rural areas but sometimes located within heavily forested regions. They require stable, highly insulated areas to hibernate. They often can take up residence in barns, silos, churches, storm sewers, copper mines, tree hollows, natural caves, or openings in rock ledges.

Predators – Owls and falcons. Young bats are vulnerable to snakes, raccoons, and cats.

Special features – Brown bats will hibernate during the winter in order to preserve energy and fat so they can survive. As with other bat species, they will use echolocation not only to navigate as they fly but also to capture their flying insect prey. Brown bats will emit a stream

of calls through their mouths, with the duration and interval of each call and between calls varying depending on their activity at the time.

ORDER RODENTIA (PORCUPINES, MICE, GOPHERS, SQUIRRELS, ETC.)

Beaver (*Castor canadensis*)

Beavers are a primarily aquatic rodent. They have a waterproof, rich, glossy, reddish brown or blackish brown coat. The beaver is also a well-known fur-bearer.

Beaver (*Castor canadensis*)
© Calgary Zoo

Size – Adults weigh between 13-32 kg, and measure about 0.9-1.17 m long (tail 0.3 m tail)

Lifespan – 10-20 years

Diet – Bark of trembling aspen tree, willows, birch and black poplar, roots, pond lilies, and other aquatic plants.

Denning and Habitat – Slow, winding streams and small lakes with soft banks. Willows, aspen and other deciduous trees are necessary for food. Lodges or houses are constructed from mud and sticks (as with dams). They are often either surrounded by water, on island, or found on the banks of lakes or streams. Beavers spend many months (up to six) under the ice. During this period their activity is restricted to under the ice. Lodges or houses also provide protection and warmth for the colony during the winter.

Predators – Wolves, coyotes, and bears are the major predators. Young are vulnerable to wolverines, lynx, fishers, and otters.

Special features – The beaver's tail is used in water as a rudder. If the beaver becomes scared it may slap the water with its tail, warning all beavers in the vicinity of the danger. This behavior may also drive away any potential predators. Beavers can make large habitat changes by cutting down trees and constructing dams. The dams are constructed with sticks and branches and sealed with mud and stones. Beavers cut down an average of 216 trees per

year with trees measuring up to 0.4 m in diameter. As beavers may need to spend months under the ice, they store these foods under the ice for access during the winter.

Beavers, as rodents, have two large incisors on both the top and bottom of their jaws. These teeth are covered with enamel and are constantly growing. Beavers gnaw on the bark of trees and grind their teeth, which helps keep these teeth worn down. Beavers also have some adaptations that allow them to move underwater. They have transparent eyelids that cover their eyes, valves in the ears and nose that can close, and a flap closing behind their incisor teeth to prevent water from entering while they swim. Beavers also have two oil glands beneath their skin on their lower bellies. They comb this oil into their fur to make it waterproof They also have two castor glands, which they use to produce a scent that they deposit on their scent mounds to mark territorial boundaries.

ORDER LAGOMORPHA (RABBITS, HARES, AND PIKA)

Eastern Cottontail (*Sylvilagus floridanus*)

Eastern cottontail rabbits are small rabbits with dense, buffy brown underfur and longer coarse grey and black-tipped guard hairs. Their ventral fur is white. They have a short tail with a white-underside. They have distinctively large eyes for their size.

Eastern Cottontail (*Sylvilagus floridanus*)
© Gareth Rasberry

Size – Adults weigh between 0.8-1.53 kg and are between 0.4-0.5 m long.

Lifespan – 2-3 years

Diet – Grasses, wild strawberry, clover, garden vegetables, woody plant parts, including twigs, bark and buds of oak, dogwood, sumac, maple and birch.

Denning and Habitat – Edge habitats including meadows, orchards, farmlands, hedgerows, and low deciduous trees. Females create nests in a hollow beneath a shrub, log, or in tall grass.

Predators – Raptors (hawks, owls), red fox, coyotes, and weasels

Special features – Eastern cottontails are solitary and tend to be very intolerant of each other. They also have very good senses of sight, smell, and hearing assisting in predator detection and avoidance. They are crepuscular and nocturnal and are active all winter. They are also very quick and can reach speeds of up to 30 km/hr. Vocalizations of the eastern cottontail can include very distinct distress cries. As the majority of its diet is cellulose and complex carbohydrates, eastern cottontails as with many rabbits and hares, use caecal fermentation to digest their food. They must reingest their fecal pellets (after going through their digestive system once) to reabsorb their nutrients.

ORDER CARNIVORA (BEARS, CANIDS, FELIDS, MUSTELIDS, SEALS, ETC.)

Black Bear (*Ursus americanus*)

Black bear and cubs (*Ursus americanus*)
© Liron Gertsman

Black bears are generally black in color but may range to lighter brown (sometimes blonde). Black bears are a wide-ranging mammal in Canada, only avoiding cities although they have been well adapted to living near humans. Black bears are thick set, bulky animals. The adult black bear has a moderate-sized head with a straight facial profile and a tapered nose with long nostrils. Unlike other animals, the lips of a black bear are not attached to their gums allowing black bears to use them with great dexterity. The eyes are small, and ears are rounded. The tail is not noticeable and very small. The feet are well furred with five curved claws.

Family - Ursidae

Size – Adult males weigh 47-409 kg. Females weigh 39-236 kg. Males are between 1.4-2.0 m long and females are between 1.2-1.6 m long (spine length)

Lifespan – 10-15 years

Diet – Emerging grasses, sedges and weeds, insects (e.g. ants, beetles, wasps, bees, etc.), leaves from trembling aspen, berries (i.e. strawberries, service berries, pin cherries, and blueberries)

Denning and Habitat – Heavily forested areas, dense bush and wooded mountains. They often den at the base of fallen trees, beneath roots, under a tree stump, overturned log, or a hole in a hillside

Predators – Older bears can often threaten young bears, as well as wolves and lynx

Special features – Black bears are generally crepuscular, although feeding and breeding activates may alter this. Black bears are also good swimmers and fast runners. They are primarily solitary, except for the close bond between the female and her young cubs and pairing for mating. Black bears go through seasonal lethargy during the winter period in which they do not eat and subsist entirely on stored fat. They may lose up to 30% of their pre-denning mass.

Arctic Fox (*Vulpes lagopus*)

Arctic foxes are a small white fox, with a short legs and a fluffy tail. They are well adapted to living in cold climates, with a thick white fur during the winter, and brown, light gray and black during the summer. Arctic foxes have two different colour morphs, the "blue" and "white", with the "white" being more common in Manitoba. In the winter, "blue" moults from chocolate brown in the summer to lighter brown tinged with blue in the winter.

Arctic fox (*Vulpes lagopus*)
© Hannah Anthony

Family – Canidae

Size – Adults weigh between 3.14-3.58 kg and are between 0.548-0.578 m long.

Lifespan – 3-4 years

Diet – Lemmings, migratory birds, eggs, ringed seals, caribou, and carcasses

Denning and Habitat – Arctic and alpine tundra, usually in coastal areas

Predators – Red fox, wolverines, golden eagles, gray wolves, and brown bears

Special features – Arctic fox are generally solitarily (other than the breeding season), and when food is abundant they will cache the food for later use. Arctic foxes have many physical adaptations to living within the arctic environment. Their fur has the best insulative properties among all mammals. They further conserve body heat by the fur on their soles of their feet, small ears, short noses, and the ability to reduce blood flow to the peripheral regions of their bodies.

Raccoon (*Procyon lotor*)

The agile, adaptable raccoon is quite distinguishable with black mask coloration over its eyes, and a bushy tail with black rings. Their forepaws look like slender human hands, making the raccoon very dexterous. Raccoons are stocky in build and range from grey to reddish brown to bluff.

Raccoon (*Procyon lotor*)
© Natural Resources Council of Maine

Family – Procyonidae

Size – Adults weigh between 1.8-10.4 kg and are between 0.6-0.95 m long. Males are slightly larger than females.

Lifespan – 5-6 years

Diet – Omnivorous and very opportunistic. They consume fruits and nuts, as well as invertebrates (e.g. crayfish, clams, and insects) and vertebrates (e.g. rodents, frogs, fish, and bird eggs).

Denning and Habitat – Variety of habitats and live comfortably around humans. They need easy access to water and prefer to live in wooded areas but have also been found in pastureland, rangeland, suburban and urban areas. They build dens in trees but also use other areas such as woodchuck burrows, deserted buildings, etc.

Predators – Coyotes, gray wolves, large hawks, owls and snakes

Special features – Raccoons are primarily nocturnal and solitary. They are very agile and climb easily. They also can swim well. Raccoons also have highly developed tactile senses. Their

forepaws are particularly sensitive. They also have a keen sense of hearing, and excellent night vision.

Canada Lynx (*Lynx canadensis*)

Canada lynx are a medium size cat with varying colouration, but normally yellowish-brown. The upper parts of their body may have a frosted grey look and the underside may be more buff. Many individuals have dark spots. They have very small tails that are often ringed and tipped in black. Lynx have triangular ears tipped with tufts of long black hairs. Their paws are quite large and furry, adapted for moving through the snow.

Canada Lynx (*Lynx canadensis*)
© Conservation Northwest

Family – Felidae

Size – Adults weigh between 4.5-17.3 kg and range from 0.67 to 1.07 m long. Males are often slightly larger.

Lifespan – 5-7 years

Diet – Lynx are strict carnivores. They are snowshoe hare specialists, but will alternatively feed on red squirrels, as well as grouse, ptarmigans, waterfowl, rabbits, chipmunks, mice, skunks, porcupines, eggs, and fish when available and necessary.

Denning and Habitat – Mature forests with dense undergrowth, but have been found in open forests, rocky regions or tundra. They make dens in hollow trees, holes in rocks, under logs, stumps and fallen timber.

Predators – Wolverines, other lynx, cougars, wolves, and coyotes

Special features – Lynx are primarily solitary and appear to be somewhat territorial. Although female home ranges may overlap, males occupy very distinct areas. Lynx primarily hunt visually but also have well-developed hearing. They primarily nocturnal and prey are generally stalked. Females have been known to hunt in cooperation with their kits, increasing their success. Lynx are well adapted to hunting in their northern range. They have long, muscular legs and large furry feet with toes that spread out giving them extra

mobility on the snow. They are also powerful fighters and good swimmers, travelling high in the water.

Fisher (*Martes pennanti*)

Fishers are a medium to dark brown mustelid with gold to silver hoariness on their head and shoulders as well as black legs and tails. They are a secretive and rarely observed mammal. Fishers are agile and fast tree climbers and are well known for their ability to walk or run down trees. They live a solitary life, using resting sites, such as logs, hollow trees, stumps, brush piles, and nests of branches throughout the year.

Fisher (*Martes pennanti*)
© John Jacobson

Family – Mustelidae

Size – Male adults weigh between 3.6-5.4 kg and are about 0.9-1.2 m long. Female adults are smaller and weigh between 2.0-2.5 kg and are about 0.75-0.95 m long.

Lifespan – 4-5 years

Diet – Fishers are predators that eat small mammals (e.g. mice, shrews, and squirrels), porcupines, snowshoe hares, carrion, birds and their eggs, insects, amphibians, and sometimes other carnivores. They also may feed on fruits and berries, including beechnuts and apples.

Denning and Habitat – Coniferous forests but also live within mixed and deciduous forests. They prefer habitats that have high canopy closures and many hollow trees for their dens. Fishers use hollow trees and logs, holes in rocky ledges, old porcupine dens, and cavities in the snow as den sites.

Predators – Cougars, lynx, bobcat, wolverines, coyotes, other fishers, and golden eagles

Special features – Fishers are known for their ability to prey on porcupine, which they kill by attacking their face and head over and over again. They waste very little of the porcupine, eating everything but the skin, large bones, feet, and intestines. They are also well adapted to walk and run on trees. Their hind feet can be turned so their claws can better grip on the

trees, similar to many species of squirrels. They also have short, heavy legs, sharp claws, and a long, bushy tapering tail that assists in balance. Fishers also have large feet, allowing them to walk on top of the snow. They have pads on each of their toes, and the middle portion of each foot. The heavy fur on their feet helps protect them during the winter.

Striped skunk (*Mephitis mephitis*)

Striped skunks are an easily recognizable small carnivore that are known for their scent glands that are used as an anti-predator defense. They have black fur with a white strip that begins on the forehead and travels down the sides of the back, merging at the tail.

Striped skunk (*Mephitis mephitis*)
© Jacob Dingel/Pennsylvania Game Commission

Family – Mephitidae

Size – Adults weigh between 1.2-5.3 kg and between 0.58-0.8 m long.

Lifespan – 2-3 years

Diet – Variety of foods, including insects, small mammals, birds and their eggs, crustaceans', fruits, grasses, leaves, buds, grains, nuts, and carrion. Insects make up a majority of the diet, including bees and ants.

Denning and Habitat – Open areas with a mixture of habitats, including woods, grasslands, pastureland, and rangeland. Suburban areas can also be suitable. They use burrows made by other animals or natural burrows, such as tree stumps or buildings. They can dig their own dens if necessary.

Predators – Great horned owls, red-tailed hawks, and other raptors

Special features – Striped skunks are primarily nocturnal, sleeping during the day. They become inactive during the winter, with females not emerging from their winter dens until the spring and males occasionally emerging when temperatures are mild. Females den together during the winter, with six females and their young.

Ringed Seal (*Pusa hispida*)

Ringed seals are a common seal throughout the Arctic, and an important prey source for polar bears. They have silver gray bellies, and their dorsal side is pale grey with dark spots surrounded with pale coloured rings. They lack ear pinnae, has a small head and plump body. Ringed seals have small front flippers with claws that are more than 2 cm thick.

Ringed seal (*Pusa hispida*)
© Waterframe/Alamay

Family – Phocidae

Size – Adults weigh between 65-95 kg and are between 1.4-1.5 cm long, with females slightly smaller than males.

Lifespan – 25-30 years

Diet – Saffron cod, arctic cod, and invertebrates such as shrimps, amphipods, and euphausiids

Denning and Habitat – Habitat that freezes to stable ice during the winter. They make lairs in the snow and ice to protect themselves from predators and shelter. They live in ice cover areas by maintaining breathing holes and cracks in the ice.

Predators – Polar bears, arctic foxes (particularly young are vulnerable), and humans

Special features – Adult ringed seals are generally solitary except for loose feeding aggregations in the summer. In late spring, ringed seals haul out onto the sea ice and bask in the sun. They molt during this period.

ORDER CETACEA
(BALEEN AND TOOTHED WHALES)

Beluga (*Delphinapterus leucas*)

The white whale, more commonly known as the beluga, is an Arctic whale well adapted to its life in the northern seas. Belugas have milk white skin, although they are born gray and their colour gradually fades with age. They lack a dorsal fin but have a shallow ridge along their back. They have narrow appendages and a melon shaped head.

Beluga (*Delphinapterus leucas*)
© Zoofari

Size – Adults weigh between 1350-1500 kg and are between 3.0-4.6 m long.

Lifespan – 25-30 years

Diet – Smelt, flatfish, flounder, sculpins, salmon, cod, and invertebrates including crab, shrimp, clams, worms, octopus, and squid

Denning and Habitat – Inlets, fjords, channels, bays, and the shallow waters of the arctic seas. They are found at the mouths of river during the summer, where they feed, socialize, or deliver their offspring.

Predators – Killer whales and polar bears

Special features – Belugas are well adapted to life in the Arctic, with a number of anatomical and physiological characteristics. They have thick blubber (up to 10 cm thick) helping them survive the cold temperatures. Their melon-shaped head is the center for echolocation. Beluga also aggregate in herds of hundreds to thousands of individuals. The exact way the belugas group is uncertain but age and sex seem to be involved.

ORDER ARTIODACTYLA (EVEN-TOED UNGULATES)

Bison (*Bison bison*)

Bison are a large species of ungulate that has been historically found across the prairies of North America. They are the largest terrestrial animal in North America. They were an important food and resource for many First Nations but were hunted to near extinction by the European settlers. Bison have a shoulder hump and huge head. Their fur is brown and longer in the front than in the rear. It has black horns curving upwards and inwards ending in a sharp tip. Its hooves are black and circular.

Bison (*Bison bison*)
© Jake Dykinga/Agricultural Research Service

Size – Adults weigh between 318-900 kg with adult males ranging in length between 3.6-3.8m and 2.13-3.18m in females.

Lifespan – 15-20 years

Diet – Grazers, primarily grasses but if needed other vegetation

Denning and Habitat – Prairies, including grasslands and open savannas.

Predators – Gray wolves and cougars

Special features – Bison live in large groups arranged according to sex, age, season, and habitat. Cow groups are composed of females, males under three years, and a few older males. Other males either live individually or in groups up to 30.

BIRDS OF MANITOBA

Manitoba has a great diversity of birds, reflecting the wide diversity of ecosystems and seasonal shifts in resource availability. Over 145 bird species live within Manitoba, with over 88% of species migrating annually.

Manitoba is quickly acquiring a reputation to be one of the best places in the world to view a large variety of birds. As our province is located in the geographic centre of the continent, we host a combination of both northern and southern species, as well as birds from both the east and west.

Birds make up the class Aves. The taxonomy of genera and species as well as common and scientific names used in this book follow the seventh edition of the American Ornithologists' Union (AOU). This document is designed to give a brief overview of many of the important bird species living within Manitoba. The document is by no means an exhaustive list of all the species within the province, as many of the songbirds are not included, as well as domestic species and rare bird visitors.

Birds of Manitoba document is first split into larger functional groups, following the AOU Checklist of North American birds. Each entry aims to give a brief description of the appearance and size of the organism, a description of their songs and calls, some life history characteristics, current population status, as well as any unique features of the specific species. Please note that although many species have different plumages depending on sex and age not all may be shown in the accompanying picture.

HOW TO IDENTIFY BIRDS

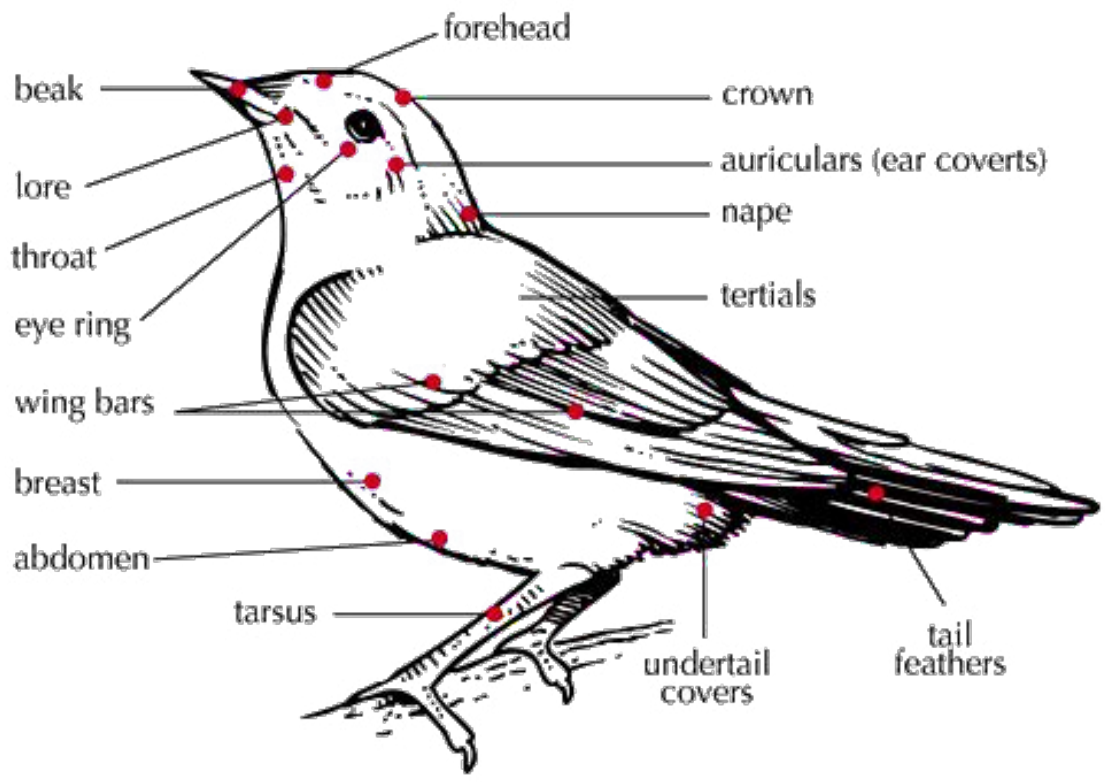
One of the challenges with identifying different bird species is that they often have different plumage in spring and summer than they do in fall and winter. Many species have different breeding and non-breeding plumages and immature birds often look different from their parents and other adults. We will focus on the plumages that you are most likely to see in Manitoba.

Birds are covered with feathers; however their bodies are not uniformly covered. The feathers grow in discrete groups, leaving other parts of the body bare. Knowing the basic feather groups and how the feathers in each group are arranged may be the most important tools a scientist can possess when trying to identify a bird by its appearance. Learning the

basis of common markings (e.g., wing-bars, eye-ring, etc.) will greatly enhance your understanding birds' appearance.

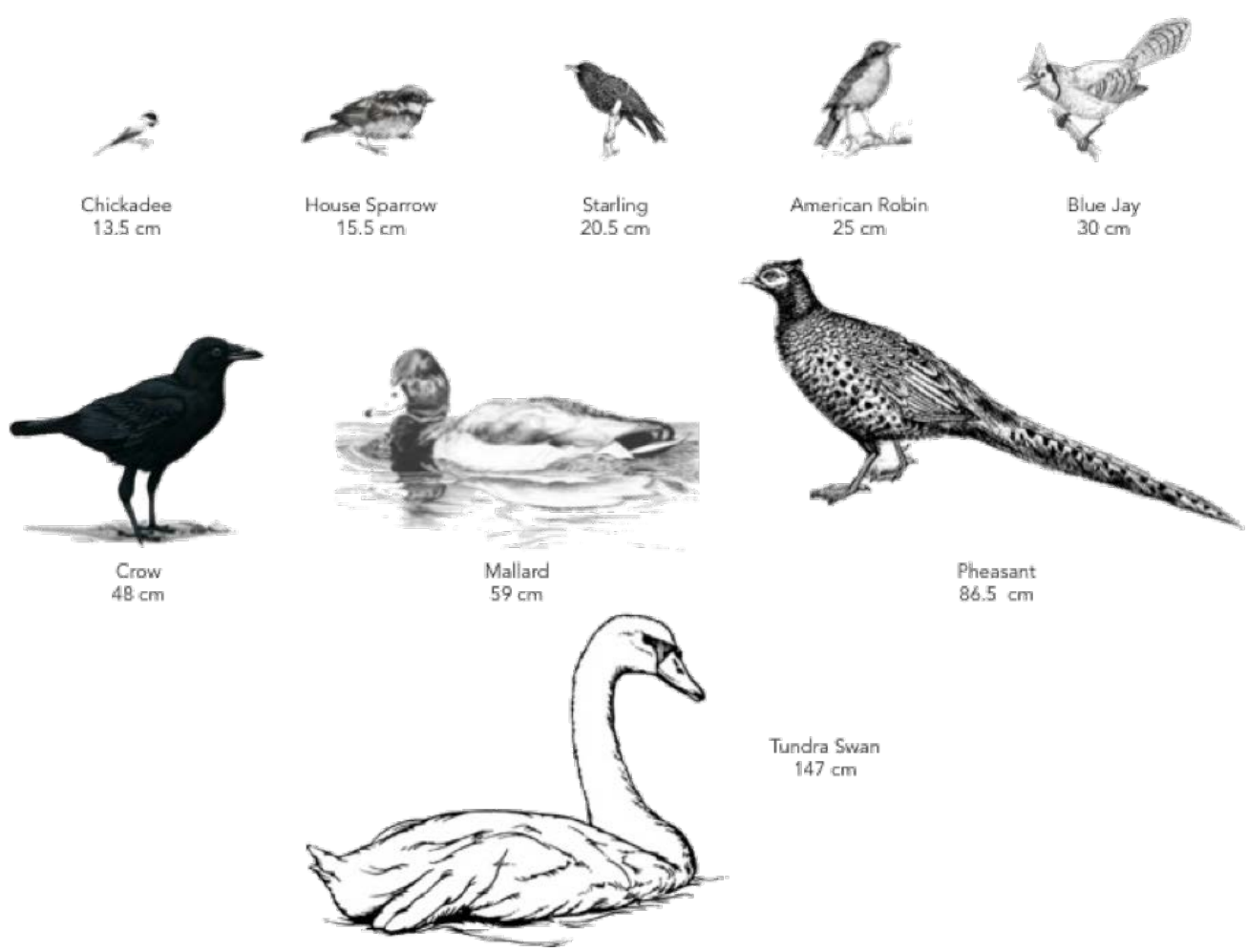
Parts of a Passerine

This figure shows the basic parts of a passerine, or songbird.



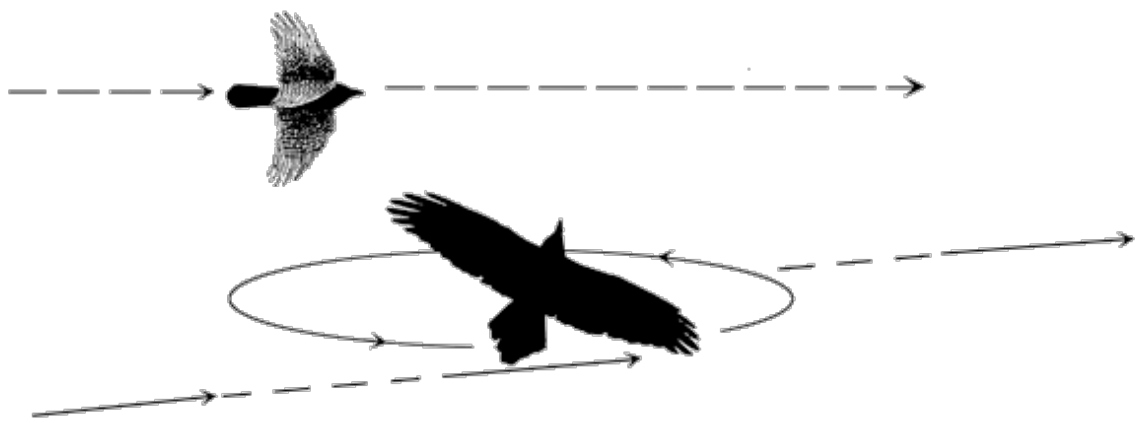
What size is it?

The best way to judge a bird's size is by comparing it with one of these nine common birds. Size is measured from the bill-tip to the tip of the tail.



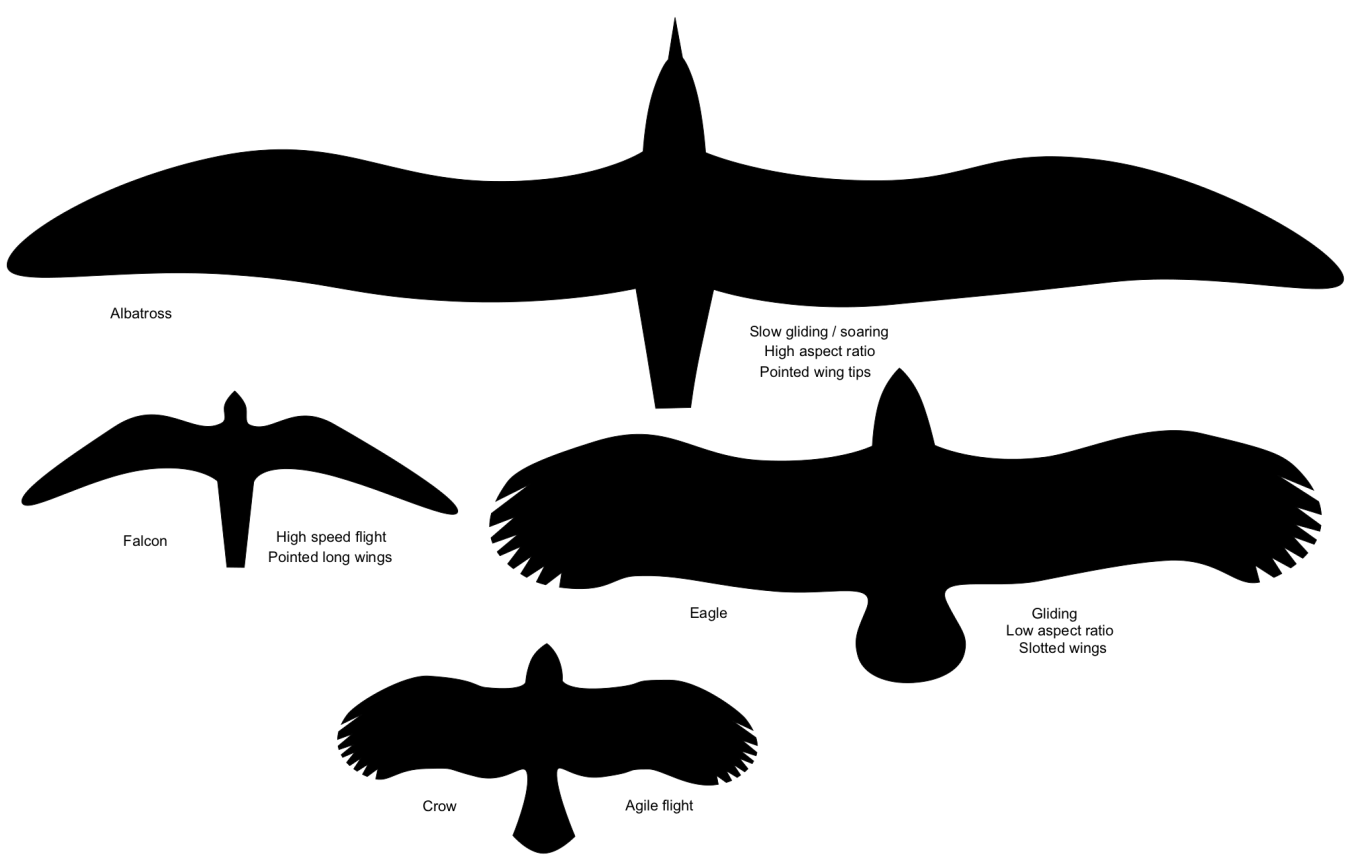
How does it fly?

Birds glide, soar, flap, hover, and perform a multitude of aerobatic tricks; and the way in which they fly can be very distinctive. A kestrel is unmistakable when hovering; so is a fly catcher when it darts from its perch to catch an insect. Some birds rise and fall rapidly, then holding them closed. For example, the difference in flight patterns between crows and ravens is illustrated below:



What shape are its wings?

Even when a bird is flying too high for anything else to show up, its silhouette is often enough to place it in a broad group; and practice at 'reading' silhouettes can lead to exact identification.

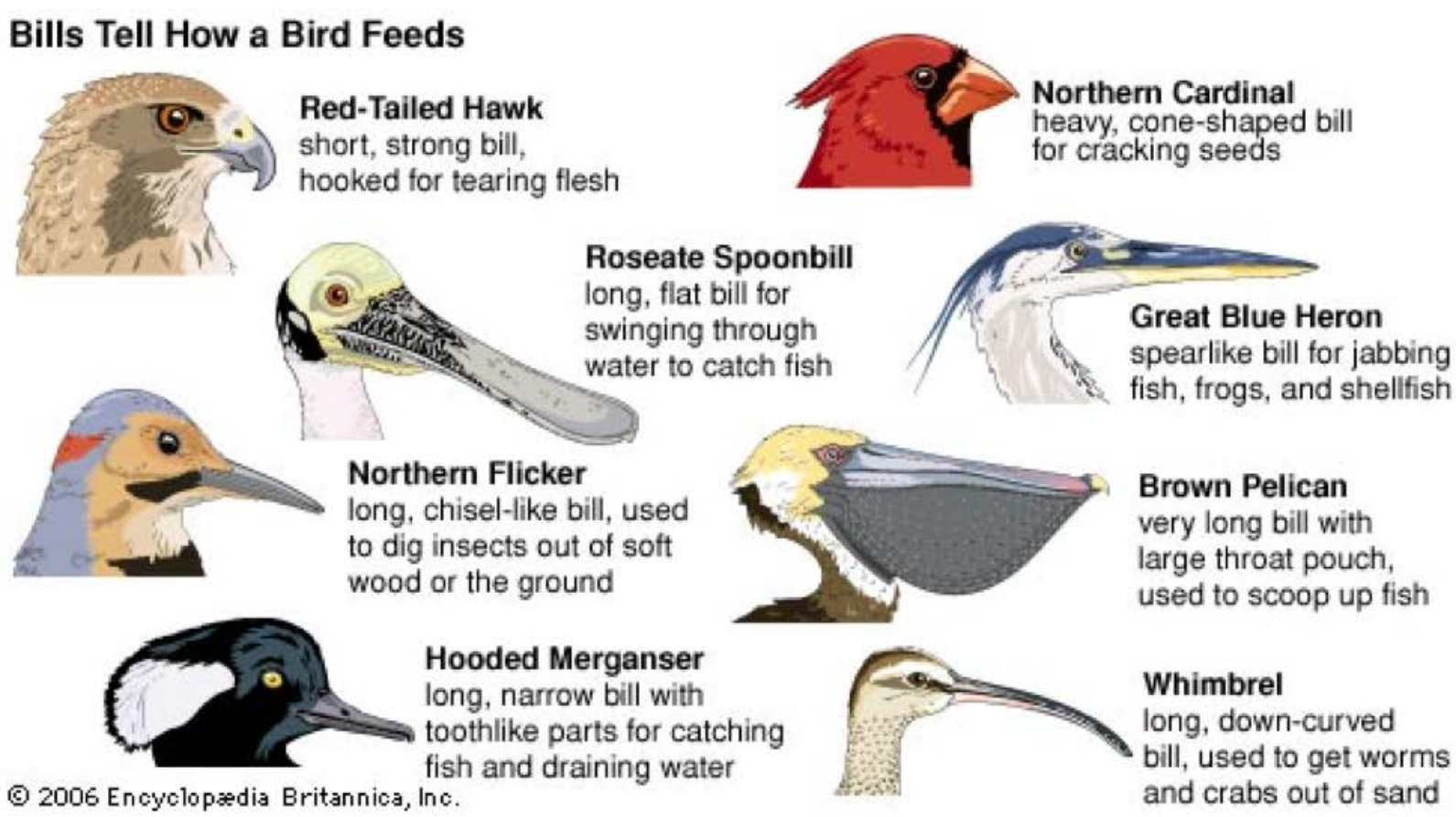


How long are its legs?

The design of a birds legs reflect its way of life or the sort of habitat in which it lives.

What shape is its tail or bill?

The shape of a bird's tail, like the shape of its wings, can be sufficiently distinctive to be a useful recognition feature even when it is flying high. A bird's bill is designed to suit the way it feeds, and the more specialized the feeding habits, the more distinctive the bird's appearance.



Categorizing Birds

Birds can be grouped based on their behaviour (rather than their biology). Four functional groups is a good place to start. Birds of prey are a predatory bird, distinguished by their hooked bill and sharp talons. Examples include owls, eagles, hawks, and falcons. Songbirds are perching birds that belong belonging to the clade Passeri often having melodious songs or calls. They are amongst the smallest of all birds and can hold tightly to branches with their toes. Examples include warblers, sparrows, and blackbirds. Waterfowl are strong swimmers with medium to large bodies. They have historically been an important food source, and continue to be hunted as game, or raised as poultry for meat and eggs. Examples include ducks, geese, swans, grebes, loons, pelicans, and cormorants. Wading birds are long-legged birds that wade in water in search of food and commonly occur in reedy areas, shallow waters, ponds, and other bodies of water. Examples include herons, rails, and shorebirds.

DIVING BIRDS

Loons, grebes, pelicans, and cormorants make up this group of waterbirds. All of these waterbirds consume fish and other aquatic animals through diving and pursuing them underwater. Loons (Family Gaviidae) are larger bodied than ducks, with their legs set far back on their bodies, and have straight, dagger-like bills. Grebes (Family Podicipedidae) appear like smaller loons with lobed toes and longer necks. Grebes fly less often and less strongly than loons. Pelicans (Family Pelecanidae) are distinguished by large skin flaps (gular skin) and webbed feet which allows them to be very efficient hunters. Finally, cormorants (Family Phalacrocoracidae) are specialized fish predators often found in flocks in any area of open water.

Common Loon (*Gavia immer*)

Size - Length 70-90 cm, Wingspan 120-150 cm

Habitat - Lake (especially with island or coves), bays, or estuaries

Food - Fish (surface dive)

Nesting - Ground

Voice - Low, melancholy yodeling or wailing cries

Common Loon
© Andrew Olynyk

Special features - The Common Loon swims underwater to catch fish, propelling itself with its feet. It swallows most of its prey underwater. The common loon has sharp, rearward-pointing projections on the roof of its mouth and tongue that help it keep a firm hold on slippery fish. Unlike most birds, loons have solid bones that make them less buoyant and better at diving. They can quickly blow air out of their lungs and flatten their feathers to expel air within their plumage, so they can dive and swim quickly.

WADING BIRDS

Wading birds are often characterized by their long legs and beaks that assist them in hunting in their preferred habitat. These birds prefer the shallow waters of marshes, swamps, mud flats and other bodies of water. The 20 species of wading birds include bitterns, egrets, flamingos, herons, ibises, spoonbills, and storks. Bitterns, herons, and egrets have long necks and long, pointed bills used to spear fish or other prey. Ibises have curved bills used to probe in the mud. Roseate Spoonbill, Wood Stork, and Greater Flamingo have specialized bill shapes and correspondingly specialized foraging methods.

Great Blue Heron (*Ardea herodias*)

Size - Length 100-130 cm, Wingspan 180 cm

Habitat - Freshwater and saltwater habitats, and also forage in grasslands and agricultural fields

Food - Fish, amphibians, reptiles, small mammals, insects, and other birds (stalking)

Nesting - Trees, usually in isolated swamps or on islands, and near lakes and ponds bordered by forests

Voice - Flight call is a very deep, hoarse, trumpeting fraaahnk or braak

Special features - Due to a specially shaped neck vertebrae, Great Blue Herons are able to curl their necks into an S shape for a more aerodynamic flight profile and allow them to quickly strike prey at a distance.

Great Blue Heron
© Pete Oxford

WATERFOWL

Waterfowl are certain wildfowl of the family Anatidae, which includes ducks, geese, and swans. Waterfowl are strong swimmers with medium to large bodies and webbed feet. They tend to prefer open bodies of water, such as lakes, ponds, and other types of wetlands. They have historically been an important food source, and continue to be hunted as game, or raised as poultry for meat and eggs. The domestic duck is sometimes kept as a pet. Swans and geese are generally larger than ducks, with long necks and feed by tipping up or grazing. They are generally found in flocks and they will call loudly in flight. Dabbling ducks (e.g., Mallard, Northern Pintail, and Wood Ducks) rarely dive, and feed mainly by dabbling their bills in the water or by tipping forward. Diving ducks (e.g., Canvasback and Ruddy duck) frequent deeper water and generally will dive underwater for food. Diving ducks are heavier-bodied so they can faster and need to run along the surface of the water to become airborne.

Wood Duck (*Aix sponsa*)

Size - Length 43-50 cm, Wingspan 70-75 cm

Habitat - Forests, swamps, marshes, and beaver ponds

Food - Seeds, fruits, insects and other arthropods (dabbler)

Nesting - Cavity (in trees, man-made structures)

Voice - Female Wood Ducks make loud oo-eek, oo-eek. Male Wood Ducks have thin, rising and falling zeeting whistle

Wood Duck
© Donna Ikenberry

Special features - The Wood Duck nests in trees near water, sometimes directly over water, but other times up to 2 km away. After hatching, the ducklings jump down from the nest tree and make their way to water. The mother calls them to her but does not help them in any way. The ducklings may jump from heights of up to 89 m without injury. The Wood Duck is the only North American duck that regularly produces two broods in one year.

BIRDS OF PREY

Birds of prey, also known as raptors, are birds that hunt or feed on other animals. The term "raptor" is derived from the Latin word rapere (meaning to seize or take by force).They are characterized by keen vision that allows them to detect prey during flight and powerful talons and beaks. Because of their predatory nature they face distinct conservation concerns. In most cases, the females are larger than the males.

Birds of prey include members of seven families: Accipitridae (hawks, eagles, buzzards, and kites), Pandionidae (osprey), Sagittariidae (secretary birds), Falconidae (falcons and caracaras), Strigidae (most owls), and Tytonidae (barn and bay owls). The variety in the wing shape and body proportions of birds of prey are related to their hunting style and preferred prey. Species with similar shapes tend to have similar habitats.

Harriers are large, slender hawk-like birds with long tails and long thin legs. Eagles tend to be large birds with long, broad wings and massive feet. Ospreys are very similar to eagles with a single species found worldwide that specializes in catching fish and builds large stick nests. Kites have long wings and relatively weak legs and they spend much of their time soaring. Hawks are medium-sized raptors with long tails for turning on tight angles. Falcons are medium-size birds of prey with long pointy wings. Owls are variable-sized, typically night-specialized hunting birds (although they are NOT all exclusively nocturnal). They fly almost silently due to their special feather structure that reduces turbulence and they have particularly acute hearing.

Great Gray Owl (*Strix nebulosa*)

Size - Length 60-84 cm, Wingspan 140-150 cm

Habitat - Boreal forest

Food - Small mammals, especially rodents

Nesting - Broken-topped dead trees or existing nest of other bird species

Voice - Series of deep, evenly spaced hoos

Special features - Great Gray Owls are Manitoba's provincial bird. Although the they are the tallest North American owl with the largest wingspan, it

Great Grey Owl
© Mary Ann McDonald

is just a ball of feathers. It preys on small mammals and has relatively small feet. Both the Great Horned and Snowy owls weigh half again as much, and have larger feet and talons

SHOREBIRDS

Shorebirds are a large group of birds that are members of the order Charadriiformes, excluding the more marine web-footed seabird groups. All are small to medium-size with relatively thin bills and long legs. They are commonly found along sandy or rocky shorelines, mudflats, and shallow waters. Many species of Arctic and temperate regions are strongly migratory, but tropical birds are often resident, or move only in response to rainfall patterns. Some of the Arctic species, such as Little Stint, are amongst the longest distance migrants, spending the non-breeding season in the southern hemisphere.

The majority of shorebirds eat small invertebrates picked out of mud or exposed soil. Different lengths of bills enable different species to feed in the same habitat, particularly on the coast, without direct competition for food. Many shorebirds have sensitive nerve endings at the end of their bills which enable them to detect prey items hidden in mud or soft soil. Some larger species, particularly those adapted to drier habitats will take larger prey including insects and small reptiles.

Shorebirds include members of 5 families: Charadriidae (e.g., plovers), Haematopodidae (e.g., oystercatchers), Jacanidae (e.g., Northern Jacana), Recurvirostridae (e.g., American Avocet, Black-necked Stilt), Scolopacidae (e.g., yellowlegs, snipe, sandpipers, phalaropes).

Killdeer (*Charadrius vociferus*)

Killdeer
© Andrew Olynyk

Size - Length 20-28 cm, Wingspan 46-48 cm

Habitat - Grassland

Food - Insects (ground forager)

Nesting - Ground

Voice - kill-deer

Special features - The Killdeer's broken wing display leads predators away from the nest. To guard against large hoofed animals such as cows,

the Killdeer uses a different display, fluffing itself up, displaying its tail over its head, and running at the beast to attempt to make it change its path.

GULLS AND ALLIES

Gulls are one of the most familiar birds and many people just call them "seagulls." However, many of these species spend little to know time on the coast. In fact, some two dozen different species of gulls live in North America.

Gulls come from the family Laridae. They are most closely related to the terns. Gulls are medium to large birds, usually grey or white, often with black markings on the head or wings. They typically have harsh wailing or squawking calls, stout, longish bills, and webbed feet. Most gulls are ground nesting carnivores, which will take live food or scavenge opportunistically. Gulls nest in large, densely packed noisy colonies. Gulls are resourceful, inquisitive and intelligent birds, demonstrating complex methods of communication and a highly developed social structure.

Many gull colonies display mobbing behaviour, attacking and harassing would-be predators and other intruders. Certain species (e.g. the Herring Gull) have exhibited tool use behaviour, using pieces of bread as bait with which to catch goldfish, for example. Many species of gull have learned to coexist successfully with humans and have thrived in human habitats. Others rely on kleptoparasitism to get their food. Gulls have been observed preying on live whales, landing on the whale as it surfaces to peck out pieces of flesh.

Herring Gull (*Larus argentatus*)

Size - Length 56-66 cm, Wingspan 137-146 cm

Habitat - Open water, intertidal pools and shallows, mud flats, landfills, newly plowed fields, picnic grounds, and fish-processing plants (and other human developments)

Food - Almost anything, e.g., marine invertebrates, fish, insects, smaller seabirds, and even on adults, young, and eggs of other gulls

Herring Gull
© David Cayless

Nesting - Ground

Voice - Variety, including ha-ha-ha-ha alarm call

Special features - An adult Herring Gull was spotted bait-fishing. It floated bits of bread on the surface of a Paris pond and attacked goldfish feeding on the bread. It ate none of the bread itself, indicating deliberate tool use.

WOODPECKERS

The woodpeckers, piculets, wrynecks, and sapsuckers are from the family Picidae. There are about 200 species in this family. Most species live in forests or woodland habitats, although a few species are known to live in treeless areas, such as rocky hillsides and deserts. Many species are threatened or endangered due to loss of habitat or habitat fragmentation.

Most species possess predominantly white, black, brown, green, and red plumage, although many piculets show a certain amount of grey and olive green. In woodpeckers, many species exhibit patches of red and yellow on their heads and bellies, and these bright areas are important in signaling. Woodpeckers and allies have strong bills for drilling and drumming on trees and long sticky tongues for extracting food. Woodpecker bills are typically longer, sharper and stronger than the bills of piculets and wrynecks; however their morphology is very similar. The bill's chisel-like tip is kept sharp by the pecking action in birds that regularly use it on wood. Species of woodpecker and flicker that use their bills in soil or for probing as opposed to regular hammering tend to have longer and more decurved bills. The long sticky tongues, which possess bristles, aid these birds in grabbing and extracting insects deep within a hole of a tree. The tongue wraps around the prey before being pulled out. To prevent brain damage from the rapid and repeated impacts, woodpeckers have evolved a number of adaptations to protect the brain. These include small brain size, the orientation of the brain within the skull (which maximizes the area of contact between the brain and the skull) and the short duration of contact. The millisecond before contact with wood a thickened nictitating membrane closes, protecting the eye from flying debris. The nostrils are also protected; they are often slit-like and have special feathers to cover them.

Downy Woodpecker (*Picoides pubescens*)

Size - Length 14-17 cm, Wingspan 25-30 cm

Habitat - Open woodlands

Food - Insects and plant materials (e.g., berries, acorns, and grains)

Nesting - Cavity (in dead trees, or dead portions of live trees)

Special features - Woodpeckers don't sing songs, but they drum loudly against pieces of wood or metal to achieve the same effect. It is sometimes thought that this drumming is part of the birds' feeding habits, but it isn't. In fact, feeding birds make surprisingly little noise even when they are digging into wood.

Downy Woodpecker
© Jim Zipp

JAYS, CROWS, AND BLACKBIRDS

Corvidae is a cosmopolitan family birds that contains the crows, ravens, rooks, jackdaws, jays, magpies, treepies, choughs and nutcrackers. There are over 120 species. They are considered the most intelligent of the birds, and among the most intelligent of all animals having demonstrated self-awareness in mirror tests (European Magpies) and tool making ability (crows, rooks). Their total brain-to-body mass ratio is equal to that of great apes and cetaceans. They are medium to large in size, with strong feet and bills, rictal bristles and a single moult each year.

Blue Jay
© Richard Day

Blue Jay (*Picoides pubescens*)

Size - Length 25-30 cm, Wingspan 34-43 cm

Habitat - Forest, particularly near oak trees

Food - Insects, nuts and seeds, grains, dead vertebrates, eggs and nestlings

Nesting - Tree

Voice - loud jeer

Special features - The Blue Jay frequently mimics the calls of hawks, especially the Red-shouldered Hawk. These calls may provide information to other jays that a hawk is around or may be used to deceive other species.

SONGBIRDS

A songbird is a bird belonging to the clade Passeri of the perching birds. This group contains some 4,000 species found all over the world, in which the vocal organ typically is developed in such a way as to produce a diverse and elaborate bird song. Songbirds are among the smallest of all birds. Warblers, tanagers, orioles, finches, and hundreds of other species make up this diverse group of birds.

Black-capped Chickadee (*Poecile atricapillus*)

Size - Length 12-15 cm, Wingspan 30-35 cm

Habitat - Deciduous and mixed forests

Food - Half plant matter (e.g., seeds, berries, etc.), and half insects

Nesting - Tree cavities (e.g., natural holes, abandoned woodpecker cavities).

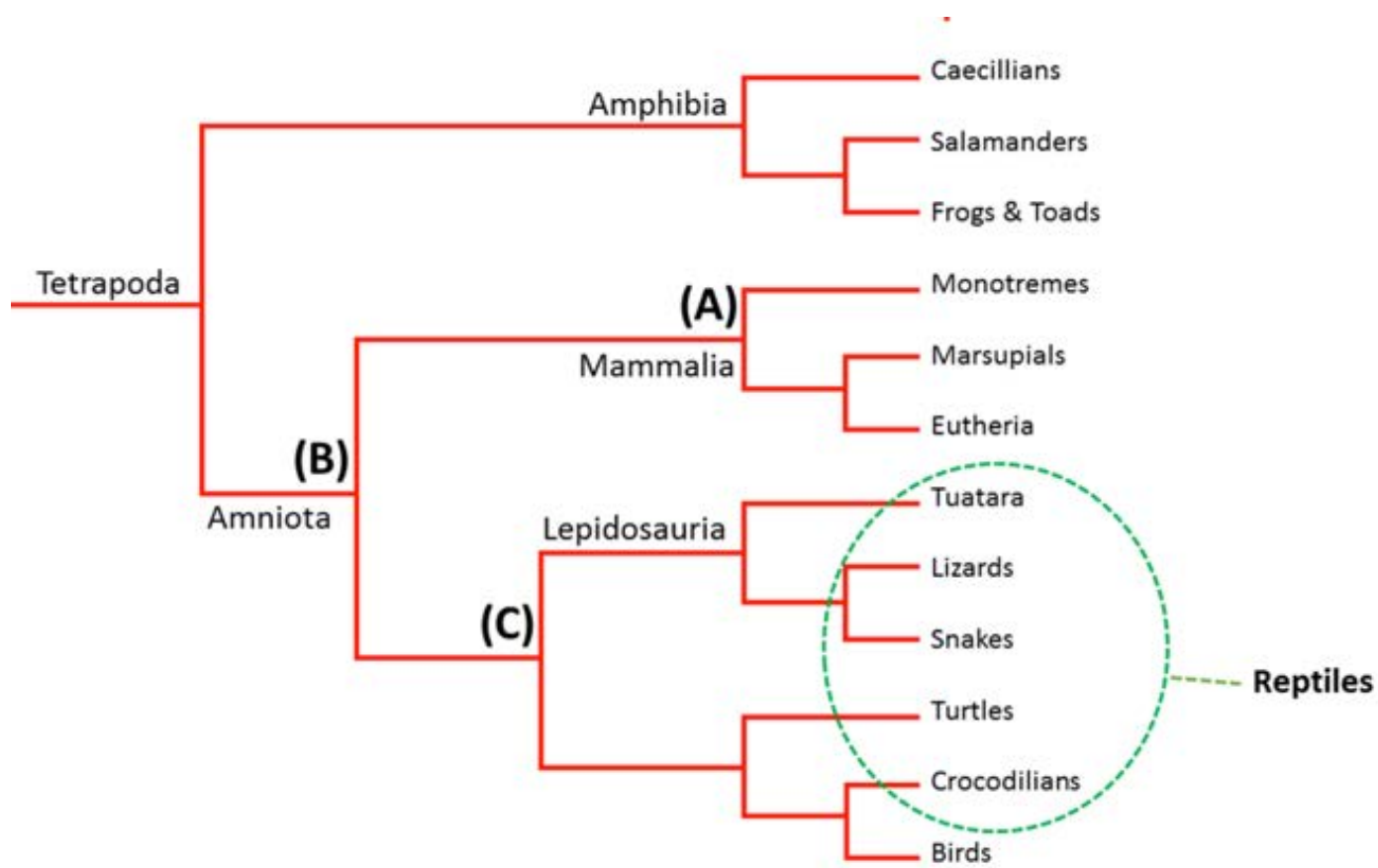
Voice - chickadee-dee-dee

Special features - Winter flocks with chickadees serving as the nucleus contain mated chickadee pairs and nonbreeders, but generally not the offspring of the adult pairs within that flock. Other species that associate with chickadee flocks include nuthatches, woodpeckers, kinglets, creepers, warblers and vireos. Most birds that associate with chickadee flocks respond to chickadee alarm calls.

Chickadee
© Andrew Olynyk

NON-AVIAN REPTILES AND AMPHIBIANS OF MANITOBA

Herpetology, from the Greek 'herpien' meaning 'to creep', is the study of amphibians (including frogs, toads, salamanders, newts, and caecilians) and reptiles (including snakes, lizards, amphisbaenidae, turtles, terrapins, tortoises, crocodilians, and the tuataras). Herpetology groups all pokilothermic-ectothermic terapods. Although many scientists would argue that this grouping is incomplete and inaccurate, as crocodilians and turtles are more closely related birds (aves) than other reptilians (e.g., lizards and snakes – see figure below) and reptiles are more closely related to mammals than amphibians, it has been used historically to group terapod species with similar characteristics. Modern classification has the group split into five categories – Amphibia (frogs and toads, salamanders, and caecilians), turtles (testudinia), Lepidosauria (lizards, snakes, tuatara), Crocodillia, and birds (Aves).



Manitoba is home to a variety of amphibians and non-avian reptiles. Although the diversity is limited due to the extreme temperatures found in our province, many species have adaptations that have allowed them to survive. Manitoba has eight species of reptiles, which consist of six squamates (five snakes and one lizard), and two turtles. We are also home to sixteen species of amphibians, which include four salamanders, twelve frogs.

AMPHIBIANS

Amphibians are a group of species that are often found living both in the water and on land. They represent one of the earliest groups of tetrapods to be found living on land. Amphibians are generally characterized by seven different characteristics. All amphibians have unique inner ear structures that allow them to be sensitive to low frequency noises. They all have a distinct type of green rods in their eyes as well as unique muscular structure operating their eyes. All amphibians have reduced ribs that do not encircle their bodies. Most amphibians have pedicellate teeth (one salamander genus and two frog genera are the exceptions). Very importantly, all amphibians have very thing glandular skin that allows them to breath through their skin. They have mucus glands to ensure their skin stays moist guaranteeing that gasses (e.g., oxygen) can pass through). Breathing through their skin is the primary method of breathing for many species (some variation between species). Animals that are classified as amphibian include frogs, toads, newts, salamanders and caecilians. Salamanders (Urodela) are elongate with a long tail. There are approximately 560 species of this amphibian. Frogs (Anurans) are tail-less short-bodied amphibians. This group includes approximate 5400 species and are often distinguished by locomotory specializations. Toads are included in this group, although there is no one group (lineage) of toads. Caecilians are a group of limbless, serpentine amphibians. They mostly live hidden in the ground, making them the least familiar order of amphibians. There are approximately 170 species of caecillians that often have skin or bone over their eyes (or no eyes) as they are blind. They have protrusible tentacles, which is unique to amphibians. Amphibians most often exhibit a 'biphasic' life cycle, where they have a larval life stage (e.g., tadpoles) and then metamorphose into an adult phase.

Manitoba has 15 species of amphibians, including four species of salamanders (e.g., eastern tiger salamander, mudpuppy, etc.) and 11 species of frogs (including toads). Interestingly, Manitoba is home to the mudpuppy, a paedomorphic species that remains active in permanent bodies of water. To survive in Manitoba all species of amphibians must have adaptations like freeze-avoidance (aquatic and terrestrial hibernators) and freeze-tolerance (allow bodies to freeze, e.g., wood frog).

Adult Wood Frog
© michigan.gov

Wood Frog (*Lithobates sylvaticus*)

Wood frogs are the colour of dead leaves so they can

hide on the forest floor.

Adult Sizes: Its body is about 5 cm long. With its legs stretched out it is about 15 cm long.

Diet: Insects, worms and other small animals without backbones.

Denning and Habitat: They spend winter under the leaves or under logs on the forest floor where they can freeze solid. Wood frogs live in forests but can be found in meadows or marshes.

Predators: Garter snakes, herons, crows, raccoons, skunks, or weasels will eat adults. Their tadpoles are eaten by shorebirds, snakes and large insects like giant water bugs and diving beetles.

Life History: Most of the breeding is from mid-April to early May. They breed in ponds filled by melting snow or in small year-round ponds. Each female lays about 1000 eggs in a round bunch on plants floating on top of the water. The eggs hatch in 3 to 5 days. The tadpoles can become froglets about 40 days after hatching.

Boreal Chorus Frog (*Pseudacris maculata*)

They are brown or green with dark stripes or patches. They can change their colour, from green to brown or make it lighter or darker. The chorus frog can climb up tree trunks and on branches. It hunts for food in low branches or on the ground. The boreal chorus frog is Manitoba's smallest frog.

Boreal Chorus Frog
©Wild Photos Photography

Adult Sizes: The body of an adult is a maximum of 3 cm long.

Diet: Tiny insects like mosquitoes.

Denning and Habitat: During the winter boreal chorus frogs sleep under leaves or logs in forests, or under thick grass in meadows. Their bodies can freeze solid. They are found mainly in forests, but lives in grasslands, marshes and even in cities.

Predators: Snakes, birds, mice, shrews, and large insects. The tadpoles are eaten by birds and large insects.

Life History: Boreal chorus frogs mate very early in spring. Sometimes they can lay eggs by early April. They breed in small ponds filled by melting snow. Each female lays as many as 200 eggs in small clumps on plants or sticks under the water. The eggs hatch in about 3 days. The tadpoles grow for about 40 days before they become froglets.

Blue spotted Salamander (*Ambystoma laterale*)

These salamanders are shiny black with light blue spots on its sides. Their belly is dark grey or black. Blue-spotted salamanders protect themselves by making a sticky bad-tasting liquid that squeezes out if they are attacked. They will also wiggle their tail to get the animal to bite the tail instead of its head or body.

Blue spotted Salamander

Adult Sizes: Between 10 cm to 12 cm long.

Diet: Worms, slugs, small insects and other tiny animals.

Denning and Habitat: They spend winter hibernating underground in the holes left by animals that burrow into the earth. Blue-spotted salamanders live in forests where the ground is damp.

Predators: Not many animals will eat blue-spotted salamanders because they have a bad taste. Snakes are likely their main predators.

Life History: Blue-spotted salamanders breed in ponds that fill from melting snow or in small permanent ponds. They mate and lay eggs in April or May. Females lay about 500 eggs, one at a time or in small bunches on sticks or plants on the bottom of the pond. The eggs take about 30 days to hatch.

NON-AVIAN REPTILES

The term reptile derives from the Latin rept-, meaning 'crawled'. A reptile is classified as any extant ectothermic sauropsid. Sauropsid is a grouping based on the evolution of the amniotic eggs (eggs with an extraembryonic membrane(s) enclosing the yolk sac). Reptiles

are considered to be a paraphyletic (incomplete) grouping as it excludes birds (as shown in above image). However, for the purposes of this document we will focus on non-avian reptiles. Most reptiles lay eggs (oviparous), however some species may have young hatch from eggs stored inside the mother (e.g., Red-sided garter snake), which is known as ovoviviparous, and some lizards and snakes may have young live born (viviparity).

Turtles are all from the family Testudines that includes over 300 species, grouped into two distinct categories. Pleurodira ("side+ neck") includes turtles that can bend neck horizontally to retract head. However this group is now restricted to the southern hemisphere. Cryptodira ("hidden+ neck") includes turtles that can bend neck in vertical S shape to retract head. Most turtles are found in this group (~230 species). Tortoises are a true grouping, including approximately 50 species. Sea turtles specifically adapted to live in the sea with flippers, and other physiological adaptations allowing them to dive deep in the sea. Turtles are classified by the structure of their shell and skeleton as well as many anatomical adaptations (e.g., their blood can bypass their lungs when they are holding their breath). Although current evidence suggests turtles are the most closely related to crocodilians and birds, this grouping is still hotly contested.

Lepidosoaurs include tuatra (2 spp.) and squamates (lizards (4800 spp.) and snakes (>2900 spp.)). These species are predominantly terrestrial, with water-impermeable overlapping scales. Tuataras have spines on there back and the only two remaining species are now found on small islands off the coast of New Zealand. They have two rows of teeth on their upper jaw and one row of teeth on their lower jaw. Interestingly, they are also nocturnal and have lifespans of up to 100 years. Lizards and snakes are known as squamates, as snakes evolved from lizards. They are characterized by changes to their skulls and jaws (e.g., larger gape allowing them to swallow food and more muscles to increase biting force), as well as their determinant growth (do not continually grow through their life, like fish, crocodiles, and birds). Squamates are split into two major groups, the Iguania (including iguanas and chameleons) and Scleroglossa (including geckos, skinks, monitor lizards, amphisbaenians (elongate legless burrowing lizards), and snakes). Approximately 80% of squamates are oviparous. Viviparity (live birth) and ovovivparity is found in over 45 lizards and 35 snakes. All boas and vipers, some iguanids, chameleons, geckos, amphisbaenians, sea snakes, and approximately 45% of skinks have live birth. Interestingly, six families of lizards (~15 spp.) and one species of snake exhibit parthenogenesis, where they produce viable eggs with out mating.

Manitoba has six squamates and two species of turtles. Most of the squamates are very limited in their distribution due to temperature constraints. Intriguingly, the world record

for highest snake density is found in Manitoba. Red-sided garter snakes congregate in the fall and spring at rock outcrops where they hibernate during the winter. The great concentration of snakes in one area facilitates mating in the spring, which females store until they have had enough food to gestate their eggs.

Red Sided Garter Snake (*Thamnophis sirtalis parietalis*)

The red-sided garter snake is the most abundant snake in Manitoba. It is one distinct subspecies of the common garter snake. To differentiate the red-sided garter from the plains garter compare the lateral yellow lines along the sides of their body. Red-sided garters have the yellow line on scale row 2 and 3, while plains garter have theirs on row 3 and 4.

Red Sided Garter Snake
© All Canada Photos

Adult Sizes: Females are typically larger than males of all year classes. Adult females are over 90 cm long while males reach a maximum length of 75 cm.

Diet: Frogs, leeches, tadpoles earthworms, and rodents.

Denning and Habitat: These snakes hibernate during the winter. Den sites include tree roots, shale cliffs, rock piles, sewers, foundations, animal burrows, rocky outcrops and sinkholes. Dens contain from a few to over 10,000 individuals. The preferred habitat of the red-sided garter snake is near ponds in areas of moderate moisture.

Predators: Magpies, owls, hawks, black bears, skunks and racoons.

Life History: In the spring, snakes emerge from the dens and breed in the area immediately surrounding the den sites. As each female emerges from the dens they are pursued by a number of males that entwine themselves around her forming a mating ball. In late summer the young are born, a female may give birth to 20 young on average.

Northern Prairie Skink (*Plestiodon septentrionalis*)

The Northern Prairie Skink is a smooth, shiny, alert lizard. The Northern Prairie Skink has an interesting protective adaptation. When pursued by a predator, the skink will use its tail as a "decoy" by detaching it. The tail will continue to twitch distracting the predator while the skink scurries for cover.

Northern Prairie Skink
© Christopher E. Smith

Adult Sizes: Between 12 cm to 20 cm.

Diet: Crickets, grasshoppers, and spiders. Other insects and insect larvae are second choice foods

Denning and Habitat: Skinks hibernate below the frost line. Their habitat includes grasslands with sandy soil. They use litter as cover as well as burrowing in sand just under the surface.

Predators: Western hognose snake, kestrels, crows, raccoons, skunks and large frogs or toads.

Life History: During the breeding season from mid-May to early June, male skinks jaws and throat begin to turn a distinctive, bright orange. After a gestation period of around forty days the female lays an average of eight eggs in a small nest cavity. The female skink broods her clutch of eggs until they hatch, afterwards the female will leave the nest.

Common Snapping Turtle (*Chelydra serpentina*)

Snapping turtles have a long neck and long tail which stretched out can be twice the length of its shell. Colour is dark brown, younger specimens appear nearly black. Snapping turtles are unable to retract their heads into their shell.

Common snapping turtle
© Center for Biological Diversity

Adult Sizes: shell length of up to 50 cm, though most adults are closer to 30 cm shell length. Females are larger than males.

Diet: Common Snapping Turtles eat many food sources. They eat aquatic animals, including fish, amphibians, crayfish, snails and other

invertebrates, but also consume aquatic plants and carrion. Small mammals and birds floating on the water surface may be eaten as well.

Denning and Habitat: Overwinters on the bottom of larger, permanent water bodies. Its habitat consists of permanent water bodies such as lakes.

Predators: Common snapping turtles have few predators as adults, but their eggs are eaten by crows, mink, skunks, foxes, and raccoons.

Life History: Mating probably takes place in May. Clutches of up to 80 eggs are laid in June in loose or sandy soil. Hatchlings emerge in September.

REFERENCES

Photos provided by a variety of sources, as cited, and including:

Andrew Olynyk

ARKive, Wildscreen. < http://www.arkive.org>

The Cornell Lab of Ornithology, All about Birds <http://www.allaboutbirds.org>

The document was compiled using the following references (please note – you are NOT responsible for anything in the following documents)

Allaby, M. 2009. A Dictionary of Zoology. Oxford University Press, New York, New York, USA.

Bat World Org. 2010. Position Statement on Banding Insectivorous Bats. Retrieved from https://batworld.org/wp-content/uploads/2011/02/BWSposition_statementbanding.pdf

Bellrose, F. C. 1976. Ducks, Geese, and Swans of North America. Stackpole Books, Harrisburg, PA.

Ben-David, M., and E. A. Flaherty. 2012. Beginners guide to stable-isotopes - from atoms to ecosystems. Journal of Mammalogy 93:312–328.

Benyus, J. Northwoods Wildlife: A Watcher's Guide to Habitats. NorthWord Press, Minocqua, Wisconsin.

Bezeber, A. and De Smet, K. 2000. Manitoba Birds. Lone Pine Publishing, Vancouver, British Columbia.

Blackshaw, J.K. and D.J. Allan. 1986. Notes on some topics in applied animal behaviour.

Bull, E. L. and J. R. Duncan. 1993. Great Gray Owl (*Strix nebulosa*). In The Birds of North America, No.41 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Butler, R. W. 1992. Great Blue Heron (*Ardea herodias*). In The Birds of North America, No. 25 (A. Poole, P. Stettenheim, and F. Gill, eds.). The Birds of North America Online, Ithaca, New York.

Canadian Herpetological Society. 2012. *Thamnophis radix* Plains Gartersnake. Carcnet. Accessed October 29th 2015. Retrieved from http://www.carcnet.ca/english/reptiles/species_accounts/snakes/T_radix/radix2.php

Clench, M., and J. Mathias. 1995. The avian cecum: a review. The Wilson Bulletin 107:93–121.

COSEWIC. 2002. Assessment and Status Report on the Great Plains Toad *Bufo cognatus* in Canada. Accessed November 25th 2015. Retrieved from http://www.sararegistry.gc.ca/virtual_sara/files/cosewic/sr_great_plains_toad_e.pdf

Dunn, E., and C. Ralph. 2004. Use of mist nests as a tool for bird population monitoring. Studies in avian biology: 1–6.

Dunne, P. 2006. Pete Dunne's Essential Field Guide Companion. Houghton Mifflin, New York.

Earth Rangers 2012. Polar Bear Update: Finding and Tracking Polar Bears. Retrieved from http://www.earthrangers.com/wildwire/take-action/polar-bear-update-findingand-tracking-polar-bears/

Echinococcosis: *Echinococciasis*, Hydatidosis, and Hydatid Disease. 2012. Pages 1–13.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye. 1988. The Birder's Handbook. Simon & Schuster Inc., New York. Sibley, D. A. 2000. The Sibley Guide

Errol J. Bredin. Biology of the Northern Prairie Skink. Nature North. Accessed November 6th 2015. Retrieved from http://www.naturenorth.com/summer/creature/skink/Fskink2.html

Evers, David C., James D. Paruk, Judith W. Mcintyre and Jack F. Barr. 2010.Common Loon (*Gavia immer*). In The Birds of North America, No. 313 (A. Poole, P. Stettenheim, and F. Gill, eds.). The Birds of North America Online, Ithaca, New York.

Food and Agriculture Organization of the United Nations. 2007. Wild bird capture techniques. *in* Wild birds and avian influenza. <http://www.fao.org/docrep/010/a1521e/a1521e00.htm>

Glahn, J. F., B. Dorr, J. B. Harrel, and L. Khoo. 2002. Foraging ecology and depredation management of great blue herons at Mississippi catfish farms. Journal of Wildlife Management 66: 194-201.

Government of Manitoba 2011. Caribou Action Plan. Retrieved from http://www.gov.mb.ca/conservation/wildlife/pdf/caribou_action_plan_11_29_2011 .pdf

Government of Manitoba. 2015. Wild Animals of Manitoba Red-sided Garter Snake Fact Sheet. Conservation. Accessed October 29th 2015th. Retrieved from https://www.gov.mb.ca/conservation/wildlife/mbsp/fs/rsgarter.html

Hare, J. F. 1998. Juvenile Richardson's ground squirrels, *Spermophilus richardsonii*, discriminate among individual alarm calls. Animal Behaviour. 55:451-460

Henry, P.-Y., and J.-C. Aznar. 2006. Tool-use in Charadrii: active bait-fishing by a Herring Gull. Waterbirds 29:233–234.

Hepp, G. R., and F. C. Bellrose. 1995. Wood Duck (*Aix sponsa*). In The Birds of North America, No. 169 (A. Poole and F. Gill, eds.). The Birds of North America Online, Ithaca, New York.

Invasive Species Council of Manitoba. 2013. Invasive Aquatic Species List. <http://invasivespeciesmanitoba.com/site/index.php?page=aquatic-species>

Invasive Species Council of Manitoba. 2013. Invasive Terrestrial Species List. <http://invasivespeciesmanitoba.com/site/index.php?page=terrestrial-species>

IUCN. 2012. IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK

Iverson, S.J., C. Field, W.D. Bowen, and W. Blanchard. 2004. Quantitative fatty acid signature analysis: a new method of estimating predator diets. Ecological Monographs. 74(2): 211-235

Jackson, Bette J. and Jerome A. Jackson. 2000. Killdeer (*Charadrius vociferus*).In The Birds of North America No. 517 (A. Poole, Ed.). The Birds of North America Online, Ithaca, New York.

Jackson, Jerome A. and Henri R. Ouellet. 2002. Downy Woodpecker (*Picoides pubescens*), The Birds of North America, No. 613(A. Poole, Ed.). The Birds of North America Online, Ithaca, New York.

Joe Crowley. 2015. Smooth Greensnake (*Opheodrys vernalis*). Reptiles and Amphibians of Ontario. Ontario Nature. Accessed November 9th 2015. Retrieved from http://www.ontarionature.org/protect/species/herpetofaunal_atlas.php

Journey North 2016. Conventional and Satellite Collars. Retrieved from https://www.learner.org/jnorth/tm/caribou/Collars.html

Kerr, G.R. and A.J. Kwasniak. Wildlife Conservation and Management. The Canadian Encyclopedia. <www.thecanadianencyclopedia.com/articles/wildlife-conservation-and-management>

Knudsen, B., and R. M. Evans. 1986. Parent-young recognition in herring gulls (*Larus argentatus*). Animal Behaviour 34:77-80.

Leighton, F.A. 2000. Winter Tick in Moose and Other Ungulates. Canadian Cooperative Wildlife Health Centre. < http://www.ccwhc.ca/wildlife_health_topics/winter_tick/wintertick.php>

Levi, T., and A. Kilpatrick. 2012. Deer, predators, and the emergence of Lyme disease. Proceedings of the National Academy of Sciences 109(27):10942–10947.

Manitoba Breeding Bird Atlas (Atlas des oiseaux nicheurs du Manitoba). 2013. <http://www.birdatlas.mb.ca>

Manitoba Conservation Wildlife and Ecosystem Protection. 2013. Living with Wildlife in Manitoba. Human-Wildlife Conflict. <http://www.manitoba.ca/conservation/wildlife/problem_wildlife/index.html>

Morris, D., S. Gilbert, Y. College, and B. Lemming. 2008. Small mammal population monitoring. Wildlife Conservation: 1–12.

Myers, P. 2001. "Annelida" (On-line), Animal Diversity Web. <http://animaldiversity.ummz.umich.edu/accounts/Annelida/>

Myers, P. 2001. "Arthropoda" (On-line), Animal Diversity Web. <http://animaldiversity.ummz.umich.edu/accounts/Arthropoda/>

Myers, P. 2001. "Chordata" (On-line), Animal Diversity Web. <http://animaldiversity.ummz.umich.edu/accounts/Chordata/>

Myers, P. 2001. "Cnidaria" (On-line), Animal Diversity Web. <http://animaldiversity.ummz.umich.edu/accounts/Cnidaria/>

Myers, P. 2001. "Porifera" (On-line), Animal Diversity Web. <http://animaldiversity.ummz.umich.edu/accounts/Porifera/>

Myers, P. 2002. "Platyhelminthes" (On-line), Animal Diversity Web. <http://animaldiversity.ummz.umich.edu/accounts/Platyhelminthes/>

Myers, P., R. Espinosa, C. S. Parr, T. Jones, G. S. Hammond, and T. A. Dewey. 2013. The Animal Diversity Web (online). <http://animaldiversity.org>

Nature North. 2008. Amphibians of Manitoba. Accessed November 6th 2015. Retrieved from http://www.naturenorth.com/1np/Species/amphibian/1Spec-am.html

Nature North. Species Accounts: Snakes (*Colubridae*) (*Natricidae*) (*Dipsadidae*). Herps. Accessed October 29th 2015. Retrieved from http://www.naturenorth.com/Herps/MHA_Snakes.html

Nature Watch. 2015. Learn About Frogs of Manitoba. Frog Watch. Accessed November 7th 2015. Retrieved from https://www.naturewatch.ca/frogwatch/manitoba/

Neil Gushulak. 2013. Have you seen this snake?. Nature North. Accessed November 9th 2015. Retrieved from http://www.naturenorth.com/winter/hognose/hognose.html

Oak Hammock Marsh. A Bird in the Hand. Retrieved from http://www.oakhammockmarsh.ca/learn/signature-experience/

Oxford Dictionary. 2015. Definition. Oxford University Press. Accessed November 13th 2015. Retrieved from http://www.oxforddictionaries.com/

Parmesan, C. 2006. Ecological and Evolutionary Responses to Recent Climate Change. Annual Review of Ecology, Evolution, and Systematics 37:637–669. doi: 10.2307/annurev.ecolsys.37.091305.30000024.

Partners in Flight. 2012. Species assessment database.

Pierotti, R. J., and T. P. Good. 1994. Herring Gull (*Larus argentatus*). In The Birds of North America, No. 124 (A. Poole, and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.

Rabies: Communicable Disease Control. 2005. Pages 1-2.

Raftovich, R.V., K.A. Wilkins, S.S. Williams, H.L. Spriggs, and K.D. Richkus. 2011. Migratory bird hunting activity and harvest during the 2009 and 2010 hunting seasons [PDF]. U.S. Fish and Wildlife Service, Laurel, MD.

Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski Jr., and W.A. Link. 2011. The North American Breeding Bird Survey, Results and Analysis 1966–2010. Version 12.07.2011. USGS Patuxent Wildlife Research Center, Laurel, MD.

Schmidt, G.D. and Roberts, L.S. 2009. Foundations of Parasitology. *Edited by* P.E. Reidy. McGraw-Hill, New York, New York, USA.

Sibley, D. A. 2000. The Sibley guide to birds. Alfred A. Knopf, New York.

Sigurdson, C. J., and A. Aguzzi. 2007. Chronic wasting disease. Biochimica et biophysica acta 1772:610–618.

Smith, R.L. and T.M. Smith. 2001. Ecology and Field Biology. Benjamin Cummings, New York, New York, USA.

Smith, Susan M. 1993. Black-capped Chickadee (*Poecile atricapillus*). In The Birds of North America, No. 39 (A. Poole, Ed.). The Birds of North America Online, Ithaca, New York.

Sodhi, N. S., and P. R. Ehrlich. 2010. Conservation Biology for All. Oxford University Press. doi: 10.1093/acprof:oso/9780199554232.001.0001.

Starkey, E. E. 1994. Disease in U.S. National Wildlife and Parks: Historical Coevolutionary Perspectives. Conservation Biology 8:654–661.

Storer, J. E. 2003. The Eastern Beringian vole *Microtus deceitensis* (Rodentia, Muridae, Arvicolinae) in Late Pliocene and Early Pleistocene faunas of Alaska and Yukon. Quaternary Research 60:84–93.

The Cornell Lab of Ornithology, All about Birds <http://www.allaboutbirds.org>

Urton, E. J. M., and K. A. Hobson. 2005. Intrapopulation variation in gray wolf isotope ($\delta^{15}N$ and $\delta^{13}C$) profiles: implications for the ecology of individuals. Oecologia. 145:317–26.

USGS Patuxent Wildlife Research Center. 2011. Longevity records of North American Birds.

Vennesland, Ross G. and Robert W. Butler. 2011. Great Blue Heron (*Ardea herodias*). In The Birds of North America, No. 25 (A. Poole, Ed.). The Birds of North America Online, Ithaca, New York.

White-nose syndrome: North America's Response to the Devastating Bat Disease. 2013. U.S. Fish and Wildlife Service. Retrieved from http://whitenosesyndrome.org

William H. Koonz. 1991. Manitoba Natural Resources, Wildlife Branch. Accessed October 29th 2015. Retrieved from http://www.naturenorth.com/spring/creature/garter/Fgarter.html

Wobeser, G. 2002. Disease management strategies for wildlife. Revue Scientifique et Technique -Office international des epizooties 21:159–178.